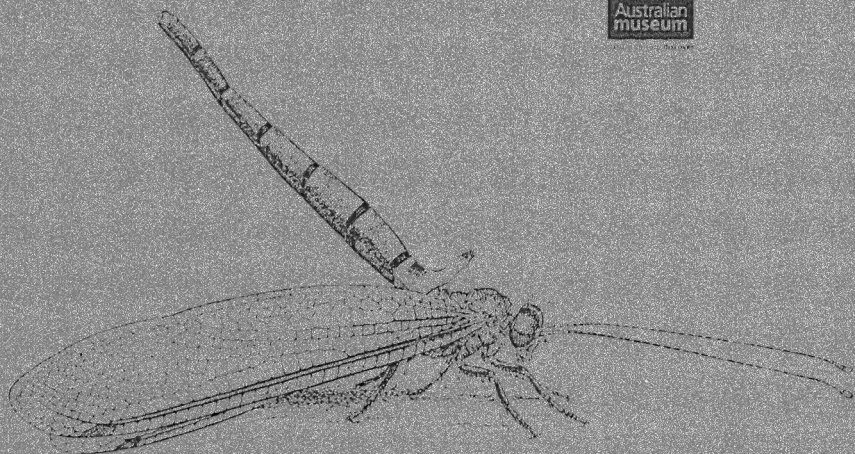


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COURTENAY SMITHERS
MEMORIAL ISSUE



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Cover: A male of *Megacmonotus magnus* (McLachlan 1871), one of the largest of the Australian members of the lacewing family Ascalaphidae. Ascalaphids are sometimes known as "owl flies" and many are partly daytime active. This species has a wing length of up to 45 mm and is very widespread in Australia, being recorded from all mainland states except Victoria and South Australia. The strange process jutting up from the base of the abdomen is found in many male ascalaphids and is of unknown function.

The illustration is reproduced by permission from CSIRO's *Insects of Australia* and is by the late Mary Quick, one of the many talented artists who worked in the 1960s on the hundreds of new insect illustrations for the first edition of this classic work.



COURTENAY NEVILLE SMITHERS

29 August 1925 – 12 May 2011

COURTENAY SMITHERS MEMORIAL ISSUE

This special issue of the *Australian Entomologist* is dedicated to the life of Courtenay Neville Smithers, who passed away in Sydney at the age of 85 on May 12, 2011. He was a big, generous man whose life encompassed three continents and whose interests in entomology were just as broad. Our frontispiece portrait shows him as Deputy Director of the Australian Museum in 1968, a position he relinquished to return to hands-on entomology.

To explore his life we have four biographical pieces. Courtenay's wife (and collecting companion) Aletta, always known as Smila, touchingly tells the little-known story of his early life in Africa and England, and how his drive to study natural history evolved. David Britton, who now sits in Courtenay's old office at the Australian Museum, describes Courtenay's career at that institution, how he revamped the displays and brought entomology to the public in many ways. David also compiled the list of Smithers' patronyms and dug into AM archives for images of the camera-shy subject. Tim New, from La Trobe University, himself a psocid worker, describes Courtenay's prodigious output of research on this group of tiny insects which he had consciously chosen as a life-long study in Rhodesia in the early 1950s. John Peters, a British lepidopterist who came to Australia a year after Courtenay, describes his energetic attempts to record and explain the migratory patterns of Australian insects. John, a close friend of Courtenay's, also unearthed an unpublished manuscript of Courtenay's dealing with the uplift of butterflies into atmospheric thermals and the implications of this on movement of insects from Australia east into the Pacific. This is included.

The other seven papers are by friends and colleagues of Courtenay who dedicate their studies to his memory. Five of them name new species after Courtenay.

We thank all the authors for their contributions to this special volume. At 128 pages, it is the largest volume of the *Australian Entomologist* produced in its 38 years. This could not have been done without extra support. Thirty-seven subscribers gave almost \$1000 to help. Thank you all. Those who wished to be named are: R. Bashford, I. Endersby, S. Ginn, R. Grandison, C. Hood, T. Houston, J. King, R. Kohout, R. Lachlan, C. Lambkin, J. Majer, R. May, G. Maynard, G. Monteith, B. Moore, M. Moulds, K. Murray, G. Owen, J. Peters, L. Willan, J. Yates.

We are especially grateful to Courtenay's home institution, The Australian Museum in Sydney, for its most generous support of this special issue honouring one of its most distinguished members of staff.



COURTENAY SMITHERS – BEFORE AUSTRALIA

ALETTA (SMILA) SMITHERS

2 Wolsten Avenue, Turramurra, NSW 2074

Abstract

The entomologist, Courtenay Neville Smithers (1925-2011), was born in South Africa and schooled both there and in England, developing an early interest in natural history. After serving in World War II, he returned to South Africa and trained at universities in Pretoria and Grahamstown, culminating in an MSc thesis on citrus entomology. While working in various applied posts in Zimbabwe (then Rhodesia) and South Africa on tsetse fly, acacia entomology and general agricultural pests, he developed an interest in taxonomy of Psocoptera and moved to the Australian Museum in Sydney, as insect curator, in 1960.

Courtenay Neville Smithers was born on 29 August, 1925 in Pretoria, South Africa. His family were of English descent and lived in Natal. His father, Robert Francis Smithers, was a public servant, later magistrate, who was also heavily involved with sports administration. At age eight his father died and in 1938 his mother, Matilda Rebecca (Tilly), with her four daughters and Courtenay made their home in England, where the eldest married daughter lived. Courtenay's four grown up brothers remained in South Africa. At this time he was too old to sit for the exam to get him into a school where he could qualify for university so he went to the local school. This particular school had a teacher who was interested in soccer and the "new" boy was soon in their first team and, as an under 13 team, they never lost a match. The boys were excused class, no matter what the subject or time of the day, to practise soccer. He was selected for special training by soccer scouts who were searching for likely lads for professional soccer clubs when they finished school. Courtenay's mother did not approve of soccer as a career so, with the help of the Methodist minister and a friendly headmaster, he was sent to a small private school. (Courtenay's passion for soccer remained with him for the rest of his life). There was little money so his mother could not afford the fees required for science lessons. He was a good student and managed to pass the Oxford School Certificate. He was a prefect and, continuing with his music lessons, played the piano for school assembly. During the nights he had to be on fire watch and in the mornings go to class as usual. In 1943, aged 18, he was called up (Fig. 1).

Courtenay was sent to Northern Ireland to train with the 1st Battalion of the Royal Ulster Rifles, 6th Airborne Division. Rigorous training across the mountains and swamps of County Tyrone prepared Courtenay for his time ahead. Transported in gliders on D-day (6 June 1944), the troops landed behind the German coastal defences in Normandy. The following morning he was captured by the Germans and, after many months in railway cattle carriages and unbelievable hardship, eventually ended up in a POW camp in Poland to work in a coal mine. When the Russian army was approaching the

whole camp started on a march to the south. Most of them died as it was in the middle of a European winter with virtually no food. The march eventually reached Czechoslovakia, where US soldiers released them in late 1945. Courtenay's survival was mainly because of the fitness he acquired while training to be an airborne soldier and his stubbornness to make it to life after the war. His brothers had fought with the South African forces.

As a schoolboy he became interested in natural history. His mother did not approve of this because, as with soccer, she felt playing with insects was no way to earn a decent living. He nevertheless roamed the English countryside collecting insects and breeding them in the garage. He became an avid birdwatcher and spent his spare time in the local library learning all he could about animals in general. One of his sisters gave him a copy of A.D. Imms' classic *General Textbook of Entomology* and with it he taught himself to use the keys to identify the insects and learn general insect biology. By the time he came out of the army in 1947 his mind was made up. He and his family had returned to South Africa after the War so he worked at any sort of job, mainly selling motorcar parts, to eke out enough money to go to university. With a small loan from the ex-servicemen's league and living with his mother, he went to Pretoria University to study BSc Agriculture, a 4-year course. After two years of trying to study in a language foreign to him (Pretoria was then an Afrikaans-speaking university), he managed to pass but realised that he knew enough entomology to teach his teacher, so he transferred to Rhodes University in Grahamstown, Eastern Cape. His two years at Pretoria did not qualify him for the formal science degree but they allowed him 1st year. That year, 1949, he met Aletta du Preez, whose home was in Rhodesia but was in her third year at Teachers' Training College in Grahamstown. She'd been known since babyhood as "Smila" because of her happy disposition and the name stuck for life.

After he graduated he decided to try for an MSc funded by African Explosives (who also made all the chemicals for agriculture). This degree had very little course work; it was mainly practical research with a thesis at the end and covered the years 1952-53. There is a very large citrus plantation near Port Elizabeth where he was given accommodation and assistance to undertake a study of all insect pests of citrus. During the season every tree was covered by tarpaulin and cyanide gas was pumped into this "tent". Courtenay had placed covers on the ground beneath each tree to catch everything that had been living in the canopy. When the covers were removed next morning the catch was stored in jars to be sorted during the day. Many hundreds of these samples were taken during the season. At the time he (mentally) thanked Imms for preparing him for sorting all these insects and this also stood him in good stead when he had a whole insect collection in his charge at the Australian Museum in later life. Smila was teaching in Rhodesia at the time and she travelled to South Africa during her school holidays to type the thesis, having learned to touch type by

correspondence especially to do this. Courtenay had neither time nor money to do it himself. Courtenay sorted the insects and wrote it all up, getting specialists from all over the world to identify to species the insects in their particular fields.



Fig. 1. Courtenay Smithers aged 18 and in British Army uniform, with his mother Matilda in England in 1944.

Now the aim was to find employment. Having a 1st class pass in both degrees in entomology and botany, Courtenay was offered some jobs, the first being at the Horticulture Department just outside Pretoria. He turned this down, not wanting to live too close to his authoritarian mother! The next one was a better paying job but with an insecticide company. He turned this down for obvious reasons. He then successfully applied to the Southern Rhodesian Government for a post in the Tsetse Fly Eradication programme.

The reason for eliminating tsetse flies (*Glossina* spp.) was to enable large tracts of lowveld (bush) country to become habitable for humans. Tsetse flies spread sleeping sickness in humans and, as the veterinary disease nagana, it kills most domestic animals. The local African population depends on cattle and goats for their living so they could not live in this huge area of country without them. The tsetse fly is small, much like an ordinary housefly, but it has a bite similar to that of a tabanid. The idea at that time was to eradicate *all* wild mammals that carry the disease but are immune to the sickness. Large numbers of African men were employed to shoot all targeted mammals. The entomologist in charge paid each man each month by counting the tails of the dead animals. They were also given standard maize meal and salt for the month and enough bullets to go on with. Their meat supply came from the animals they shot. Courtenay was also employed, apart from supervising the monthly gathering of all the hunters, to study the tsetse fly populations, where they were most numerous and so on. These counts were made by driving slowly (the pace of a walking mammal) with the workers collecting all the flies that settled on the green coloured truck in small butterfly nets (Fig. 2). Every tenth of a mile the truck stopped and the collected flies were counted and sexed. There were usually no roads and they drove through the bush following blaze marks on trees, often with one of the African staff walking ahead to find the next marked tree. Their first car (Fig. 3) was understandably kept for town use!

For Courtenay this was a wonderful job. He saw all the animals in the bush at close quarters. The elephants wreaked damage to plant life as they meandered through the bush, warthogs dug holes, lions lived freely among the other animals, antelopes of all types were plentiful and it was a wonderful life for a man used to life in England or in a city in Africa. He was too busy doing his daily chores to think about normal insects and in life afterwards he always regretted not being able to collect insects in that uninhabited area of Africa. Later he was moved to a more civilised part where aerial spraying was tried. Here the country was more open and so long tracts of bush and valleys considered suitable were measured out by compass bearings and marked by long poles with balloons at the ends for small crop-dusting planes spraying insecticide to kill the tsetse flies (and all other insects too). From earlier studies it was found that tsetse flies spent daytime hours in these valleys and could thus be more easily destroyed there instead of trying to spray the whole



Fig. 2. Courtenay Smithers at the wheel of the green truck used in testse fly transect surveys at Sebungwe, near Bulawayo, Rhodesia in early 1950s with the help of African assistants.



Fig. 3. Courtenay and Smila with their first car, outside the school where Smila taught near Salisbury, Rhodesia, in the early 1950s.

countryside. There are people living in these places now, so presumably some of these practices were successful.

Courtenay really loved the life (Fig. 4) and especially being in close contact with the animals and the birds. He realised that there was no future in trying to kill all mammals; it was wrong policy and he did not want to be involved with that type of work. He was also not really a field worker by nature and needed a more academic type of work. He applied for and got a post in Natal at the Wattle Research Institute, affiliated to the University of Pietermaritzburg. At that time Australian wattles (*Acacia decurrens* Willd.) were planted in huge plantations all over the hills. The trees grew in rows for miles and they were pruned by cutting off the side branches at the bottom, so that the trees grew very tall and straight. After 10 years they were cut down and the bark removed and the tannin extracted to be used in the leather tanning industry. (These days artificial tannin is used). Courtenay was left in charge of the Entomology Department while the chief entomologist went to Europe on 6 months leave. This was an opportunity for Courtenay to do something just for himself. He chose the main pest of the wattles, the bagworm moth *Kotochalia junodi* (Heylaerts) and its parasitic wasp, the ichneumonid *Sericopimpla sericata* (Kreichbaumer). The bagworm lives on other acacia species in Africa but the wattle plantations were an ideal single species planting and he found it an ideal life history study. These pest bagworms are sometimes so numerous that they can defoliate whole trees, and from the air patches can be seen where large numbers of trees have been stripped.

The newly hatched larvae leave the parent bag and waft in the breeze on a silken thread to a likely host tree where it spins a little cocoon. The wingless female lives in this all her life, never emerging; she eats the wattle leaves and uses the small stalks to build her bag, enlarging it as she grows. The male lives in a similar bag but, when adult, it flies in search of a female. They copulate through the end of her bag. When the eggs hatch, the larvae leave the bag and waft away to find a suitable place to live. In the lab a great many bagworms were cut open; when carefully done the insect inside continues life apparently unconcerned. During the season the life history was completed and a paper on the study was prepared and published in the journal of the Entomological Society of Southern Africa. On his return the chief entomologist was not too pleased that his junior did all this without his knowledge. Anyway that was the end of Courtenay's decision making. Thereafter he had to toe the line and do as he was told. The work continued. There was more aerial spraying of plantations and cooperation between the wattle plantation owners. This was the second time that Courtenay was sprayed with insecticide while supervising aerial spraying not wearing protective clothing. Pietermaritzburg is a very pleasant town near the Drakensberg Mountains and would have been a lovely place to make a home.



Fig 4. Courtenay with butterfly net and rifle in the field at Sebungwe.

Courtenay and Smila were married in Pietermaritzberg in 1954 (Fig. 5) and at this time she taught in a beautiful school: St. Charles College. He became more and more restless at work and frequently disagreed with his senior till one day things became very heated and Courtenay went home and discussed the situation with Smila. The next day he gave notice. They lived for six months on her teacher's salary while they looked around for a new post.

It was soon after they were married that they discussed his choice of an insect group to study. He was drawn to parasitic wasps. His old professor, John Omer-Cooper at Rhodes University, was a water beetle specialist and he was keen on a student to follow in his footsteps. Smila really liked these insects but Courtenay wanted a group that had not been "messed about" by specialists. He decided on Psocoptera, a group that he thought was small in size and in the number of genera. They spent every weekend in the country searching for psocids, but soon began to find suitable methods of identifying the sort of trees where they were likely to be found and methods of collecting. While he was unemployed he was given laboratory space, use of their library and a key to rooms at the Natal Museum. This was a marvellous opportunity to begin his card indexes, to write to all the living people still working in the group and to find papers of everything ever published. This continued all his life.

Eventually he decided that he would like to live in Rhodesia, where Smila had grown up. He went back to Salisbury (now Harare) in 1956 to work in the Entomology Department and Smila started teaching at David Livingstone School, a short walk away from the Research farm where all the agricultural offices were and experimental work on crops was carried out. Rhodesia was a wonderful country to live in while David Livingstone was a beautiful modern school and life was full of promise. Work for Courtenay and the other entomologists consisted of studying all pest species connected with agriculture and also other duties like handing out permits for introducing new plants, inspecting plant nurseries and so on. Work was pleasant but there is always a problem area. Farmers would consult the department about pests: army worm, tobacco beetle, maize stalk borer, water weeds on dams, even ageing maggots on corpses and so many other problems. But the staff could never run experiments on pests, usually only suggesting insecticide remedies and hoping for the best. All this time psocids were the evening occupation for both of them. Every weekend was spent collecting and sorting. Life was good. All holidays were spent in game reserves, on rivers looking at water birds, always with collecting materials and butterfly nets.

Courtenay was making a name for himself as a specialist in psocids. He was also involved in bird watching groups, going on field trips with other international zoologists, mammalogists, ornithologists and botanists, many of whom stayed with them in Salisbury. It was a place where naturalists liked to visit to see the wild life, to see the insect collections and life was good. The



Fig. 5. Courtenay and Smila at their wedding in Pietermaritzberg, South Africa in 1954.

climate in Salisbury was excellent, people were friendly, servants affordable and entertaining was no problem, but there is always a niggling and the problem was that Courtenay did not like taking orders and doing other seniors' bidding. He became restless once more and tried to find an occupation somewhere where he could make his own decisions.

The Australian Museum was the answer! So once more they packed up, Smila very reluctant to leave home to go into the unknown. At least in Sydney people spoke the same language and Courtenay had his own department. This was 1960 and was to be their final move. Museum work and life in Australia suited them well.

COURTENAY NEVILLE SMITHERS – HIS CAREER IN AUSTRALIA

DAVID R. BRITTON

Australian Museum, 6 College Street, Sydney, NSW 2010 (Email: dave.britton@austmus.gov.au)

Abstract

Courtenay Smithers was an entomologist on the staff at the Australian Museum from 1960 until his retirement in 1985. He remained as a senior fellow with the Museum until his death in 2011. During this time he was actively involved with the Australian entomological community in many areas, as well as with the general public and in other areas of the natural sciences.

Museum life in the 1960s and 70s

Anthony Musgrave was the Curator of Insects at the Australian Museum from 1920 until his unexpected death from a heart attack on June 4, 1959. Musgrave had planned on retiring in 1960-61, so the Museum had advertised to replace him in anticipation of this retirement. After a diverse early entomological career in South Africa and Rhodesia (now Zimbabwe), Courtenay Smithers was looking around for employment outside Africa (A. Smithers 2012) and received responses from the Australian Museum and CSIRO. The Museum offered him a job while Musgrave was still alive, but Courtenay never got to meet him. He took up the post of Curator of Insects at the Australian Museum on February 12, 1960 (Anon. 1960).

Courtenay's first impressions of Australia and Sydney were not at all favourable. They landed in hot weather and were immediately driven from the airport at Mascot, which he recalled as being 'odoriferous', to a hotel booked by the Museum. The hotel was '... less than desirable could I say. It was unliveable actually'. There were two hotels of the same name and the Museum clerk had accidentally booked them into the wrong one. The Smithers endured one night there and then moved to a boarding house in Coogee, where they stayed for several months until they could find a better arrangement. After this things improved greatly.

At this time the Entomology Department staff comprised Courtenay, David McAlpine, who was the Assistant Curator, and a technical assistant, Romola Wilkinson. Subsequent technical assistants included Klara Kota (1962), Dianne Raffles (1964), Janet O'Hare (1965), Janet Walsh (1965), Robyn Jeffrey (née Pettett) (1967), Clare Trickett (1970), Lynn Hoskins (1971), Robyn Brewer (née Spalwit) (1974), Christine Horseman (1974) and Barbara Duckworth (1975). Because of the work load in the Department, Courtenay was able to get a fourth position for a technical officer, a position which was filled by Geoff Holloway in 1966 and later by Barry Day in 1978, when Geoff became Collection Manager of Entomology. This position was largely needed to assist with the numerous enquiries that arrived in the Department. Other staff working as research assistants, often on specific projects, included John Peters (1968), Margaret Schneider (1974), S.P. Kim (1974), Justine

O'Regan (1974) and Greg Daniels (1976). Mike Gray was appointed as assistant curator for Arachnology in 1968. The staff members in 1981 are shown in Figure 1.



Fig. 1. The Australian Museum Entomology Department staff in 1981. From left: David McAlpine, Barry Day, Deborah Kent, Geoff Holloway, Robyn Brewer and Courtenay Smithers.

Overall, there were far fewer staff at the Museum compared with the present institution and the workplace had a strong family atmosphere. The Director of the Museum at this time was John Evans, who was also an entomologist. Evans had a strong vision for development of research and exhibitions at the Museum and, under his leadership, the institution went on to become an internationally recognised force in the natural history sciences. This climate of cooperation and improvement was ideal for Courtenay and resulted in significant growth of the insect collections (including by public donations: e.g. Fig. 2) and improvement in the way they were housed (Britton 2011).

Courtenay also initiated the design of new modular cabinets for the collection (Britton 2011). He noted that one of the key design criteria was that the empty cabinet shell could be lifted by two average women, as Public Service regulations held that women on staff weren't allowed to lift above a certain weight. This is why Australian Museum cabinets have a somewhat unusual and elongate profile, with the drawers arranged in two tiers with each tier holding seven drawers.



Fig. 2. Courtenay Smithers (right) at a function in the Australian Museum galleries in 1978 to receive the donated butterfly collection of David Rushworth (left).

One of the areas where development occurred was in field work. When Courtenay arrived at the museum there was only one Museum vehicle, which was a small delivery van. Shortly afterwards, the Museum managed to obtain a 4WD vehicle, which was probably a first for a museum in Australia. A collecting trip was planned for Cape York Peninsula and, fortunately for Courtenay, one of the occupants pulled out leaving space for him to go. He had only been in Australia for a few weeks and had no collecting equipment, so he had to rush to equip himself. The trip was hard work and they were away for almost three months. They followed the telegraph maintenance track, getting as far as the then flooded Archer River (Cogger 1961). Subsequent trips over the next few decades took him to Lord Howe Island, Norfolk Island, New Zealand, Papua New Guinea and many other islands in the Melanesian arcs. He saw no boundary between work and the rest of life, so wherever he went he and his wife Smila collected. Indeed Smila was probably the more productive when it came to collecting.

From 1967 to 1970, Courtenay took on the role of Deputy Director at the Museum (Strahan 1979), plus running the Entomology Department and being Secretary for the International Congress of Entomology Organising Committee (Britton 2011). The work load and responsibility must have been tremendous and Courtenay recalled 'I don't know that I lost all my hair then but I certainly lost a lot of it. A lot of it went grey.' The Deputy Director's role was largely administrative and Courtenay felt that his skills as an

entomologist, including over 15 years of research on Psocoptera, were wasted in the Deputy Directorship. He characterised the administrative role as 'Here I am writing to the Public Works Department asking them to fix the toilets, when I have now arrived at the point where I can make a contribution (to the systematics of Psocoptera).' In 1970 he stepped down and continued on as Principal Curator until his retirement in 1985 (Britton 2011).

Courtenay's contributions to insect taxonomy are discussed by New (2012), but as well as publishing on Psocoptera, Neuroptera and Mecoptera he managed to cover a diversity of other topics relating to natural history. He published articles on all of the major insect Orders, covering topics such as conservation, behaviour, life history, ecology, economic entomology and taxonomy, as well as introductory manuals for insect study and collecting. A full list of refereed publications can be found in Britton (2011), with extra minor writings listed at the end of this volume. He was an early supporter of the *Australian Entomological Magazine* (now *Australian Entomologist*) when it was established by Max Moulds in 1974 and published many articles in this journal.

Exhibitions and Public interaction

One of Courtenay's early plans for the Museum was to prepare new insect exhibits to take advantage of the innovative skills of a young, talented and very active team working in Exhibitions and Preparation Departments at that time. It was not until the 1980s that this goal was achieved. The project team, consisting of a core of Courtenay, Bob Ross-Wilson, Roland Hughes and Janette McLeod, commenced meeting in late 1982. The development and construction took over two years, with the gallery opening in early 1985 with a total of 45 display cases featuring insects, spiders, worms, molluscs and other invertebrates (Fig. 3). Courtenay was charged with coordinating text content as well as helping source specimens, either through field work with Science and Exhibitions staff or by purchase from various specimen dealers. The project team meeting notes at the time detail just how many different people were drawn into the development of this gallery, including entomologists, arachnologists, collectors and natural historians such as Densy Clyne, Martyn Robinson, Glenn Hunt, David McAlpine, Mike Gray, Geoff Holloway and George Hangay.

Part of this gallery is still on display and it is still well utilised, as it represents one of the few places in Australia where you can see a comprehensive display detailing all of the insect orders present in Australia, along with appropriate scientific interpretation and, for many groups, real specimens. The gallery was also considered very advanced at the time, because it not only sought to outline the diversity of Australian insects and invertebrates but also had sections dealing with ecology, environment, behaviour, conservation, toxicology and other themes relating to these organisms.

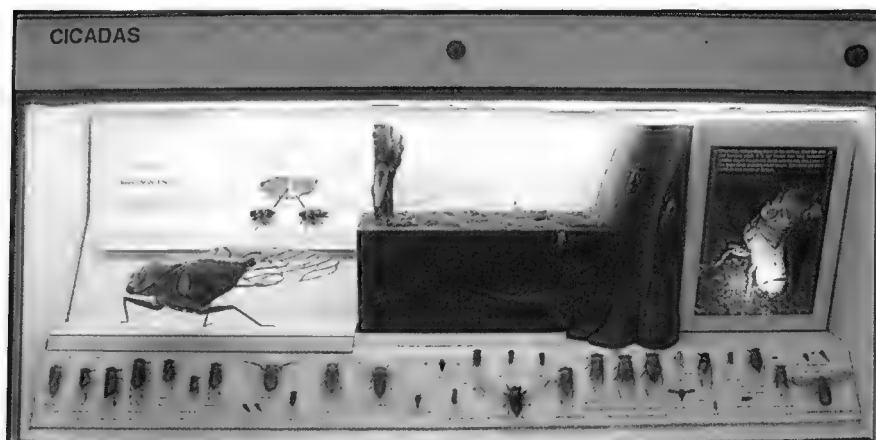


Fig. 3. A case on cicadas from the new Australian Museum insect gallery opened in 1985. It showed how models, real specimens, photographs and dioramas could be combined with good scientific information to give a striking overall effect (Australian Museum photo).

Courtenay's research interests also expanded, including projects investigating butterfly migration, the results of which are discussed by Peters (2012). This project was notable in that it had a strong public involvement, with 'collaborators' from all over eastern Australia involved in both marking and recapturing butterflies. They remember it fondly and it helped network a large number of amateur enthusiasts, some of whom went on to become entomologists later in life. Shane McEvey recalls that because he was on Courtenay's file as a collaborator, it meant that even as a teenager from Melbourne he could visit Sydney, drop into the Museum and get to see the collection and talk to real scientists.

Courtenay's interest in migratory behaviour illustrated another facet of his personality that contributed to his success as a scientist and natural historian. He was a compulsive note taker and always jotted down details on insect, bird and other natural events around him. He knew that it was not possible to remember key details, such as the direction of a flight of butterflies, so all of this got recorded. For example, he recorded daily the birds at the feeder at his home in Turrumurra.

Role in formation of the Australian Entomological Society

When Courtenay arrived in Australia from Rhodesia, he was surprised that there was no national society equivalent to the Entomological Society of Southern Africa and that there was no national forum for Australian entomology (Marks and Mackerras 1972, Britton 2011). His Director, John Evans, who was then the Australian representative on the Permanent Committee of the International Congresses of Entomology, supported the

view that a national body was needed and discussed this with Bruce Champ from the Entomological Society of Queensland (Marks and Mackerras 1972). Courtenay and Champ arranged a meeting of entomologists during the August meeting of the Australian and New Zealand Association for the Advancement of Science (ANZAAS) in Sydney. It was attended by 30 entomologists and chaired by Courtenay. As recorded in Marks and Mackerras (1972), discussion was particularly vigorous and Courtenay somewhat fondly recalled one irate NSW supporter of 'State rights' referring to him as 'that bastard Smithers'.

Marks and Mackerras (1972) documented the subsequent formation of the Australian Entomological Society (AES). Courtenay regularly attended the AES conferences (Fig. 4), was very proud of his role in the Society's birth and was granted an Honorary Life Membership in 1983 (Britton 2011). He acted as inaugural Editor of the AES News Bulletin (now *Myrmecia*) from 1965-68 and was AES President from 1977 to 1980.

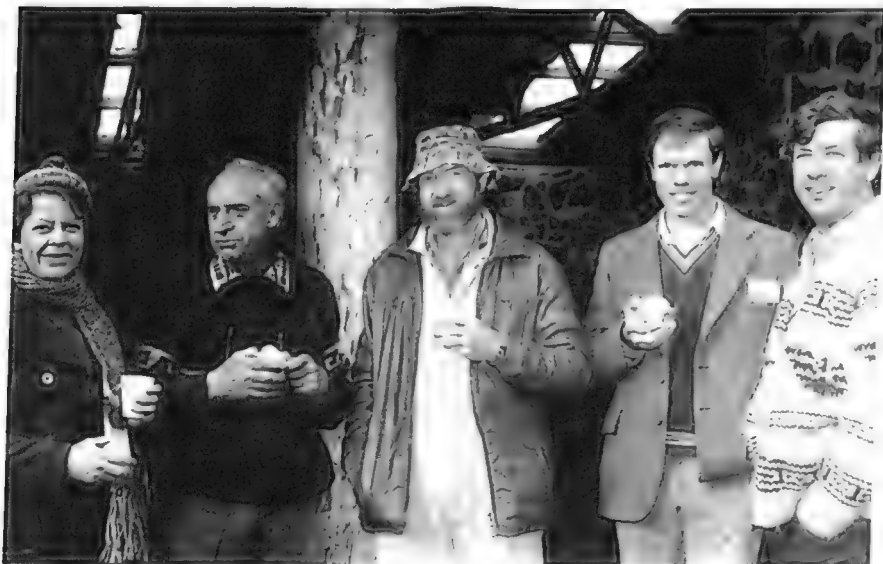


Fig. 4. At Mt Field National Park, Tasmania, on an outing from the annual conference of the Australian Entomological Society in 1985. From left: Margaret Schneider (UQ), Courtenay Smithers (AM), Tom Weir (ANIC), Greg Daniels (UQ) and Geoff Holloway (AM). All except Tom Weir had worked with Courtenay at the Australian Museum (Photo: Geoff Monteith).

Role in the 14th International Congress of Entomology, Canberra

Courtenay attended the International Congresses of Entomology held in 1964 in London and in 1968 in Moscow (New 2012) and dryly noted that he 'learnt how to run a congress' at the former and 'how not to run a congress'

at the latter. Courtenay and Doug Waterhouse (CSIRO Entomology) drafted a formal submission on behalf of the Executive of the AES to the Council of the Australian Academy of Science, requesting that the Academy issue a formal invitation in conjunction with the AES to the Permanent Committee of International Congresses of Entomology (Wharton and Marks 1968). The Academy agreed to be joint sponsor for the congress and Waterhouse was nominated to be the Australian representative on the Permanent Committee. An Advisory Committee was appointed by the Academy, with Courtenay as secretary to the Committee (Marks 1968). The recommendation that the 14th Congress be held in Australia was formally accepted by the Permanent Committee at the final plenary session of the Moscow Congress (Anon. 1968) and Courtenay became the Congress Secretary.

Much of the coordination of Congress, inviting speakers, drawing up a program, promotion of the Congress and many other tedious and detailed tasks, was done with the help of Smila. Courtenay set up a makeshift office in a tiny garden shed in the backyard of their home in Turrumurra for handling Congress communications. He sent out a first promotional Circular on the Congress to almost 10,000 recipients in early 1970, along with providing advertisements to the major journals such as *Nature* and *Science*. Regular updates on the progress of the Congress Committee were published in issues of the AES News Bulletin. By mid-1971, almost 1,800 delegates had given expressions of interest (Smithers 1971), all of whom received correspondence back from the Smithers' garden shed office. Courtenay shifted his office to Canberra in early 1972 to be closer to the rest of the Congress working group from CSIRO, Australian National University and other institutions in preparation for the final stages in organising the Congress, which ran in late August, 1972. A total of 1,323 attendees were present at the Congress, with 720 papers presented at over 21 Symposia (invited papers) and 15 Sections (submitted papers) (Smithers 1972).

Other interests

Before Courtenay and Smila left Rhodesia, they saw a Doberman bitch at an obedience trial and fell in love with the breed. They decided that when they got a dog it would be a Doberman. When they arrived in Australia, they discovered that there were very few examples of the breed in the country and it took a while to find a good one, but they eventually did. It was a characteristic of Courtenay that he never just dabbled with a new interest; he went in boots and all. He took a course on becoming a show judge for the Doberman breed and, when overseas on entomological business, managed to find time to visit Germany and talk to the German Doberman breeders. He ended up doing the commentary at the Royal Easter Show in Sydney for the Massed Obedience Display, which consisted of over 100 dogs in the arena at one time doing obedience trials. This drew upon his military background, as he had received training in radio broadcasting during WWII.

A similar result occurred when Courtenay started keeping bee hives in the backyard at Turrumurra. He tried them at Tuglo (see below), but they did not do well and died out. When Smila became sensitized to bee stings he set up his hives at his son's property near Wollombi, where they thrived. The honey was sold to a health food shop or used to "bribe" neighbours. As a result of his developing interest in this area, he published 'Backyard Beekeeping' (Smithers 1987), a popular guide which was updated and reprinted in 1992 and 2011 under different publishers. He regularly lectured to bee clubs and his phone number was listed as a catcher of feral bee swarms.

Courtenay loved classical music, which was always a loud accompaniment to his desk work at home. He played piano for relaxation and, as Smila recalls, 'whenever anything annoyed him he would take it out on the piano!'

'Tuglo', the family's nature retreat

In 1972, Courtenay and Smila purchased 'Tuglo', a largely forested 200 ha property on the southwestern slopes of Mt Royal, 36 km north of Singleton and not far from Barrington Tops. The property became a regular retreat for Courtenay and his family and he recalled spending 105 weekends there between August 1976 and April 1979 (Smithers 1981). He took an interest in almost all aspects of its natural history. He collected data on butterflies, birds and mammals on the property from 1972 onwards, as well as collecting various insects with Malaise traps and other methods. This resulted in some large collections of insects, which are held in the Australian Museum collections, as well as a series of papers on the ferns (Smithers 1978), birds (Smithers 1980), Papilionoidea (Smithers 1981), Megaloptera, Mecoptera and Neuroptera (Smithers 1993), Peripsocidae (Smithers 1994a) and HesperIIDae (Smithers 1994b).

Courtenay regularly referred to the property as 'Tuglo Wildlife Refuge' in print. Though it was always intended as a wildlife refuge and had National Parks signs declaring it was a wildlife sanctuary, the property was never formally gazetted as such. It was visited by many naturalists and natural history societies over the years, adding to Courtenay's own observations on its plants, birds and other wildlife. When the children, Graeme and Hartley, grew older they spent much time riding horses on the property and nearby ranges. Courtenay and Smila also planted South African proteas on the property. When their elder son, Graeme, graduated from his degree in horticulture, he purchased the adjacent property to set up a commercial flower farm growing proteas and other commercial species while living on Tuglo. Graeme has since retired from supplying flowers to florists but is still resident part-time on the property.

Retirement from the Museum

Courtenay retired at 60 in 1985 from his salaried position as Principal Curator. As with many other entomologists, Courtenay's retirement (Fig. 5)

from a paid position simply meant that he had much more time to get on with his entomological research without the interruptions of administration and other onerous tasks that come with paid work. He set up a lab on the back verandah of the house in Turrumurra and did most of his research work at home. He always came in to the Museum for one day each week, where he could access the research library and catch up with Museum life. He published over 80 refereed articles and books after retirement (Britton 2011) and continued his writing and research right up until his death on May 12th, 2011.



Fig. 5. Courtenay Smithers (centre) in retirement in 2006 with his wife Smila and Barry Day, assistant in entomology at the Australian Museum for many years (Photo: Max Moulds).

Acknowledgements

Details for this biography were largely drawn from autobiographical notes that Courtenay left with Smila Smithers, from the Australian Museum Archives Department, including transcripts of an oral history taken in July, 2004, and from personal conversations with Courtenay. In particular, I would like to thank Vanessa Finney and Rose Docker from the AM Archives Department and Carl Bento and James King from AM Photography for scanning and preparing photographic material from the Archives. I would also like to acknowledge the assistance of John Peters, Max Moulds, Shane McEvey, Smila Smithers and Geoff Monteith in recalling details about Courtenay and suggesting sources of information.

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COURTENAY NEVILLE SMITHERS: HIS SCIENTIFIC CONTRIBUTIONS TO THE 'SMALL ORDERS' OF INSECTS

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Abstract

Courtenay Smithers' contributions to the knowledge of Psocoptera and other orders, notably Neuroptera and Mecoptera, are summarised. They extended over some 50 years and established him as a leading authority on these orders. His contributions to systematics, biogeography and biology of Psocoptera, particularly within the Australian region, were accompanied by compilations of global catalogues and bibliographies of immense value to others. His many publications assure him of a persistent place in the history of psocopteran studies.

Introduction

Courtenay Neville Smithers (1925-2011) was known and respected widely as an excellent naturalist with a keen, life-long sense of curiosity and wonderment that led to a variety of scientific interests, together with an enduring enthusiasm about communicating his passions to others. These personal traits rendered him a highly effective publicist for entomology and led to his writing of several books to introduce insects to the wider public. His 1971 'Australian Insects in Colour', with Anthony Healy, was a pioneer in all-colour popular publication, while his 'Handbook of Insect Collecting', first published in 1981, remains a useful and readable resource. His 'Backyard Beekeeping' has just been republished 25 years after it first appeared in 1987. However, his major formal scientific contributions focused on studying the systematics and biogeography of a commonly ignored insect order, the Psocoptera, augmented by original contributions on two other 'small orders', the Neuroptera and Mecoptera. His studies on these insects assure him of a lasting place in their documentation.

Psocoptera

Smithers' taxonomic interest in Psocoptera (the barklice and booklice) flowed from the 1950s (A. Smithers 2012), with his first papers on these insects (in 1956) the source of a stream that reached more than 150 contributions over more than half a century and established him firmly as a leading world authority for much of that period.

When I started to work on British psocids (in 1965), I wrote to Courtenay at the Australian Museum for his advice, and his kind and encouraging response – together with a set of his reprints then available – marked the start of a long friendship founded in our mutual interests in 'the other orders'. I met him first in England in 1967 and next at the XIIIth International Congress of Entomology in Moscow (August 1968), an occasion that marked perhaps the first major international gathering of psocid workers, with several meeting for the first time (Fig. 1); it was not until the 1980s that such a meeting of psocopterists, always few in number, was held again. Following my arrival in Australia in 1970, we continually exchanged ideas on psocids and lacewings.



Fig. 1. Gathering of psocopterists outside Moscow University, August 1968. Left to right: A.M. Nadler (USA), T.R. New (UK), A. Badonnel (France), I.W.B. Thornton (Australia), C.N. Smithers (Australia) (Photo: V.N. Vishniakova).

While most of his published work deals with systematics, distributions and relationships of psocids, Courtenay was always aware that he was dealing with dynamic living organisms and, somewhat unusually for that era, his taxonomic studies flowed in large part from material collected during his own field studies, rather than from specimens mostly collected by others and submitted for identification. Biological oddities intrigued him greatly. One such was his discovery of the remarkable phragmotomic nymphs of *Psilopsocus mimulus* Smithers (Figs 2-3), which resemble small bark beetles and live in twigs, blocking the entrance to their tunnels with their heavily sclerotised abdomens (Smithers 1995). His knowledge spanned the world fauna.

Among his first major self-appointed tasks was to bring together the then very widely scattered literature on Psocoptera into a single, easily available and convenient format: his 'Bibliography of the Psocoptera' (Smithers 1965, with drafts circulated to most specialists for comment and augmentation) was of incalculable value to tyros such as myself. His comment in the introduction that it was 'an attempt to provide a working tool which will relieve students ... of the drudgery of compiling their own bibliographies' was indeed pertinent. The Bibliography was followed by a World Catalogue of species (Smithers 1967). The two works together provided, for the first time, a firm basis for later studies; subsequent progress in understanding

Psocoptera over the last half century is largely due to Smithers' Herculean efforts in producing these accounts. It is worth remembering that these compilations were made long before availability of computers, email and even routine use of photocopiers – so that obtaining and checking the numerous obscure references for verification could entail weeks of patience awaiting international postage, or laboriously copying out details by hand during sporadic visits to major institutional libraries. They were followed (Smithers 1972) by publication of his Ph.D. thesis, a global synthesis of psocid classification and phylogeny, with illustrated diagnoses of all genera and families then known and discussions of putative relationships that set a basis for much later consideration. It remains a potent reference source of earlier information and diagnoses.



Figs 2-3. The wood-boring psocid, *Psilopsocus mimulus* Smithers: (2) adult male from Lindfield, NSW (AM Paratype K68224); (3) final instar nymph with abdomen modified to plug burrow, from same series (Photos: D. Britton, Australian Museum)

These landmark publications were revised later, with new keys to families and genera (Smithers 1990), a revised Bibliography (with Charles Lienhard: Smithers and Lienhard 1992) and Smithers' magisterial joint volume (Lienhard and Smithers 2002), as a world catalogue and bibliography, updating these to comprise perhaps the single most significant publication ever issued on the order. The classification used there was essentially that of Smithers (1990) and pre-dated current opinion that the order is not monophyletic but intertwined intricately (as 'Psocodea') with the true lice, Phthiraptera (Yoshizawa and Johnson 2006).

Psocoptera had become much better known between 1967 and 2002, in no small part reflecting the impact of the publications noted above in collectively facilitating the perspective needed for others to study these insects. The known richness of Psocoptera rose from 1605 species (in 197 genera) in 1964 to 4408 species (371 genera) by 2000, together with an increase from 31 to 41 generally recognised families. Smithers was an active contributor to this increase. Alone or with his collaborators (notably the late Ian Thornton and in associations that led to global dominance of Psocoptera

studies by Australians for some two decades), he described somewhat more than 350 new species of psocids, across about 25 families. Many of these came to his attention though extensive field work and collecting in Australia and – with Thornton – during a major Australian Research Grants-funded survey during the 1970s of the various islands, including New Guinea and the Melanesian Arcs, to the north and east of Australia.

While his first major regional synopsis dealt with the psocids of Madagascar (Smithers 1964), his first paper from the Australasian region (following his move from South Africa to the Australian Museum in 1960) dealt with Philotarsidae from Macquarie Island (Smithers 1962). However, the account that founded his reputation in the Australasian fauna was a major paper on the New Zealand fauna (Smithers 1969), with 15 new species bringing the country's total to 43 species. His early African experiences assuredly whetted his appetite for biogeographical puzzles centred in the 'southern continents' and the regional fauna remained his primary focus for many years. From the early 1960s he published notable species additions and family synopses of the Australian psocids and, by the time he prepared the entry on Psocoptera for the Zoological Catalogue of Australia (Smithers 1996), he had described well over a third of the Australian species then known. These included records of several families new to the country, as well as a number of novel genera that hinted at the considerable complexity and high levels of endemism of the fauna. His successive chapters in the original (1970) and revised (1991) editions of 'The Insects of Australia' revealed an increase from 120 to 299 species over that period. Regional accounts, such as for South Australia (Smithers 1984) and (jointly) for Norfolk Island (Smithers and Thornton 1974) and Lord Howe Island (Smithers and Thornton 1975), were augmented by substantial family accounts for the Melanesian Arc psocids that collectively set a new perspective for their diversity and evolution within the region.

Families such as Philotarsidae, Calopsocidae, Myopsocidae and Psocidae proved to be far more diverse, intricate and biogeographically informative than suspected before these studies began. Elucidating their features did much to enhance understanding of the Australian fauna and how this had developed. Many of the places visited in Melanesia had never been explored properly for psocids, although the few taxa described sporadically from New Guinea and elsewhere suggested the likely richness of those areas. The fieldwork in remote areas was sometimes hazardous, frequently adventurous and innovative. Courtenay recalled some of these adventures in our tribute to Ian Thornton (New and Smithers 2004). However, his dedication and care resulted in the Australian Museum now housing one of the all-time greatest and most representative collections of this order.

Smithers's seminal work on psocids has been commemorated by his colleagues by seven species named '*smithersi*'. One of these he himself

synonymised, a step that accorded him some amusement. Members of the genus *Sigmatoneura* Enderlein (Psocidae) are characterised by extensive sexual dimorphism, so that males and females can be associated clearly only by co-incidence. Before this sexual difference was appreciated, I had described a male and female from Nigeria (collected at the same general locality but a year apart) as separate taxa (New 1973). Courtenay later decided that the more parsimonious approach was to consider them conspecific; unfortunately, the second described was '*smithersi*'. In the same paper, though, he also sunk *Scaphopsocus* Smithers as a new synonym of *Sigmatoneura*! Two other psocid species are named '*smithersorum*', acknowledging Smila's continued encouragement and support throughout their long partnership. Courtenay himself named a number of psocids '*alettae*' in appreciation of Smila's notable contributions. Two patronymic genera also exist: *Smithersia* Thornton (Myopsocidae) and *Smithersiella* Badonnel (Caeciliusidae).

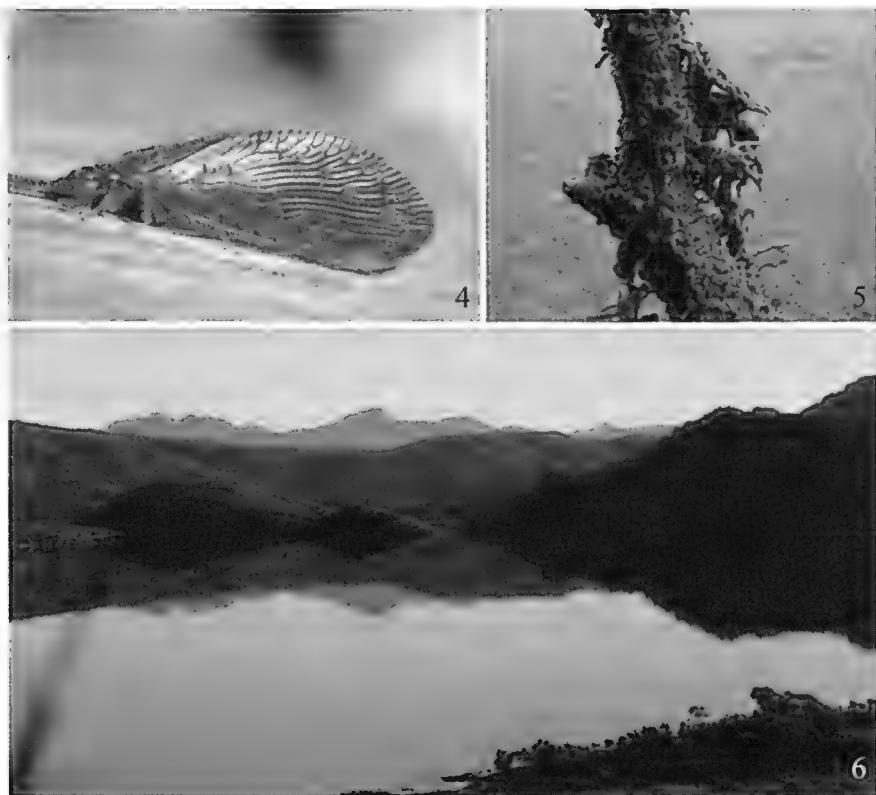
Neuroptera

The psocopteran patronyms are augmented by five patronymic lacewings, marking another of his favourite insect orders. Courtenay's interest in Neuroptera was also a long one and, although he did not publish as extensively on them, his knowledge was broad and exceptional. He described a number of new Australian species, across four families, and wrote a number of biological notes. Sadly, his long-projected revision of Australia's spongeflies, Sisyridae – a project we talked about at our first meeting, when I was able to show him one of the three British species in the field – was not completed, although he described several new species in isolation, including *Sisyra pedderensis* Smithers, an endemic to Tasmania's Lake Pedder (Smithers *et al.* 2008) and the last insect he described (Figs 4-6).

Other Orders

His interests in 'the other orders' also included Zoraptera (the chapter in 'Insects of Australia') and Mecoptera, for which he described a remarkable endemic genus, *Tythobittacus*, from the Blue Mountains (Smithers 1973) and produced a synopsis of Australian taxa (Smithers 1987). A full bibliography of his publications is given by Britton (2012).

In an era in which specialisation is the norm, Courtenay Smithers' entomological interests remained broad, but never forgoing depth and authority. His commitment to advancing knowledge of Australian insects was coupled with an equally strong commitment to their conservation. His legacy is enduring and few could claim to have changed perspective of any insect order to the extent that his studies on psocids, in particular, have done. His responses to queries were always generous and informative and the encouragement he gave to me, and to other less experienced colleagues, will be remembered with gratitude and affection.



Figs 4-6. Adult, host and habitat of the spongefly, *Sisyra pedderensis* Smithers from Lake Pedder, Tasmania: (4) adult female (Photo: G.N. Forteath); (5) encrusting freshwater sponge, *Radiospongilla pedderensis* Osborn, Forteath and Stanisic, larval food of *Sisyra pedderensis* (Photo: A.W. Osborn); (6) Lake Pedder, Tasmania, type locality of both species (Photo: A.W. Osborn).

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LIST OF PATRONYMIC TAXA DEDICATED TO COURTENAY SMITHERS

Compiled by David R. Britton

Two genera and 31 species of insects and arachnids are dedicated to Courtenay Smithers as follows (all Insecta unless otherwise stated):

Genera

Smithersia Thornton & Browning, 1992 (Psocoptera: Myopsocidae)

Smithersiella Badonnel, 1977 (Psocoptera: Caeciliusidae)

Species

Allocaecilius smithersi Lee & New, 1992 (Psocoptera: Pseudocaeciliidae)

Anthicus (Aulacoderus) smithersi von Hille, 1984 (Coleoptera: Anthicidae)

Bagauda smithersi Wygodzinsky, 1966 (Hemiptera: Reduviidae)

Bittacus smithersi Londt, 1972 (Mecoptera: Bittacidae)

Capillopsocus smithersorum Mockford, 1978 (Psocoptera: Amphipsocidae)

Clematoscenea smithersi Endang & New, 2010 (Psocoptera: Psocidae)

Clinopsocus smithersi New, 1972 (Psocoptera: Elipsocidae)

Coniocompsa smithersi Meinander, 1972 (Neuroptera: Coniopterygidae)

Delias mysis smithersi Daniels, 2012 (Lepidoptera: Pieridae)

Drosophila (Sophophora) smithersi Bock, 1976 (Diptera: Drosophilidae)

Epicaecilius smithersorum Mockford, 1999 (Psocoptera: Caeciliusidae)

Heteroconis smithersi Meinander, 1969 (Neuroptera: Coniopterygidae)

Javapsocus smithersi Endang, Thornton & New, 2002 (Psocoptera: Psocidae)

Lachesilla smithersi Garcia Aldrete, 1990 (Psocoptera: Lachesillidae)

Leptoperla smithersi Theischinger, 1981 (Plecoptera: Gripopterygidae)

Limnophila (Elaeophila) smithersi Alexander, 1958 (Diptera: Limoniidae)

Mesopsocus smithersi Badonnel, 1982 (Psocoptera: Mesopsocidae)

Molophilus (Austromolophilus) smithersi Theischinger, 2000 (Diptera: Limoniidae)

Nanolpium smithersi Beier, 1964 (PSEUDOSCORPIONES: Olpiidae)

Phyllodes imperialis smithersi Sands, 2012 (Lepidoptera: Erebidae)

Plexitartessus smithersi F. Evans, 1981 (Hemiptera: Cicadellidae)

Polyrhachis smithersi Kohout, 2012 (Hymenoptera: Formicidae)

Rhachiberotha smithersi Tjeder, 1959 (Neuroptera: Berothidae)

Scaphopsocus smithersi New, 1973 (Psocoptera: Psocidae)

Symphorobius smithersi Tjeder, 1961 (Neuroptera: Berothidae)

Tarlina smithersi Gray, 1987 (ARACHNIDA: Araneae: Gradungulidae)

Teratomyza smithersi McAlpine, 2012 (Diptera: Teratomyzidae)

Thaumastopsaltria smithersi Moulds, 2012 (Hemiptera: Cicadidae)

Theristria smithersi Lambkin, 1986 (Neuroptera: Mantispidae)

Tridactylus smithersi Günther, 1978 (Orthoptera: Tridactylidae)

Ziridava smithersi Holloway, 1977 (Lepidoptera: Geometridae)

A TRIBUTE TO COURTENAY SMITHERS AND HIS BUTTERFLY MIGRATION STUDIES

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Abstract

The contribution of Courtenay Smithers to Australian butterfly migration studies is discussed and a few noteworthy migrations not previously published are recorded.

Introduction

I first met Courtenay Smithers in 1961. I had recently arrived in Australia from the United Kingdom and Courtenay had arrived from Rhodesia less than twelve months previously. We shared an interest in British birds and both of us had prior experience with butterfly migration. Courtenay had witnessed the mass migrations of the African Migrant, *Belenois aurota* (Fabricius, 1793) and I had reported on records of migrant butterflies in Ireland.

In the 19th century, British lepidopterists found it difficult to accept that butterflies migrated. They could not '*account for an almost complete absence one year followed by a superabundance the next. They somehow believed that butterflies successfully 'hibernated' to re-emerge the following spring and that, being very mobile, their presence in large numbers was the result of movement from elsewhere in the kingdom*' (Salmon 2000).

Williams (1930) documented early studies on butterfly migration. Common and Waterhouse (1972, 1981) devoted almost four pages to it, with special reference to the work of the entomologists at the Australian Museum, in particular the marking of the wings of the Monarch followed by release and, hopefully, the eventual recapture of some of the specimens. Details were given of the need for recording butterfly migrations: *i.e.* species name (and specimens), locality, compass direction, time of day, date and the number of individuals passing over a measured distance in a given time.

A migration is noted when 'large numbers of butterflies may be seen flying in one direction for hours on end or for several days' (Common and Waterhouse 1972). These butterflies fly with a purpose and are rarely distracted from it; they fly over buildings or trees rather than fly around them. On the other hand, there are 'some species of butterflies that may, in favourable seasons, extend their distribution southward by hundreds of kilometres' (Common and Waterhouse 1972). Sydney is an ideal place to record these range extensions, as many of Courtenay's record show. Temporary range extension or full-on migration must be important to the biology of each species involved and is a part of butterfly biology that certainly needs further investigation.

Shortly after arriving in Australia, Courtenay started to bring together all the records of migrating butterflies that he could find, along with new and current records from members of the Entomology Section of the Royal Zoological

Society and from the many correspondents who were part of his Monarch (*Danaus plexippus* (Linnaeus, 1758)) labelling project (Fig. 1). Much of this information was published from 1961 to 1995 in the 28 papers he wrote dealing with butterfly migration. He first published on insect migration in Australia as early as 1961, followed by a paper on butterfly migration in 1963. His series of papers entitled 'Migration Records in Australia, parts 1-5' (Smithers 1970b, 1978, 1983a, 1983b, 1985) brought together most of the previous records of Australian butterfly migration, plus those involving the Odonata, Homoptera, Coleoptera, Diptera and Hymenoptera.



Fig. 1. Volunteers Justine O'Regan and Alana Thomas helping Courtenay Smithers tag and record Monarch butterflies in the 1960s.

***Danaus plexippus*, the Monarch butterfly**

On 8 August 1962, Courtenay and I commenced the first marking of Monarch butterflies (*Danaus plexippus*) in Australia, by using tiny handwritten labels glued to the underside of a hind wing using Mendene thinned with ethyl acetate (Fig. 2), with some successfully recaptured (Fig. 3). In 1963, the programme commenced in earnest, using small self-adhesive labels produced by Avery Scales; however, this still required the numbers to be handwritten. The cell of a forewing had the scales removed by gently rubbing between finger and thumb and the label then folded and attached to the wing (Fig. 4) – this meant that there was no need to use glue (a rather messy procedure) and the label was more easily seen. This method had been used earlier by Canadian researchers. Courtenay, through the Australian

Museum, gathered together a great many collaborators from all over Australia, but mainly from NSW, and many thousands of Monarchs and other species were labelled, with the results of this study published by Smithers (1972, 1977).



Fig. 2. Monarch number 995 marked with a trial label glued to hindwing underside.

A landmark in Australian Monarch studies was when the first overwintering aggregation sites were recorded by Smithers (1965) south-west of Sydney (Fig. 5). I have a note recording that, on 23 April 1967, at the Razorback (near Camden, NSW) overwintering site, a small group of us labelled 1,400 Monarchs in one day from the very large clusters that had assembled that winter. I'm not sure how many butterflies were labelled during the entire length of the programme but I still have a few unused labels and the numbers on them are in excess of 69,000.

The Canadian Entomologist Frederick Urquhart pioneered the labelling of *Danaus plexippus* and the results of his studies into the movements of the Monarch in North America were published in his book (Urquhart 1960). Courtenay was able to discuss his own studies on the Monarch with Urquhart during a visit to Toronto, Canada in 1986. His Australian studies were included in a review of Monarch migration in Australia by James (1993).



Figs 3-4. Tagged Monarchs, *Danaus plexippus*: (3) recaptured number 4733 with hindwing tag; (4) Canadian example with forewing tag.



Fig. 5. Courtenay Smithers collecting Monarch butterflies at an aggregation in 1968.

***Belenois java teutonia*, the Caper White**

A species conspicuously absent from Courtenay's reviews was the Caper White, *Belenois java teutonia* (Fabricius, 1775). He had so much material on the migrations of this butterfly, much of it from his many correspondents as well as his own records, that he often expressed frustration that the job of making any sense of it seemed insurmountable, particularly as he was so involved in his museum work as well as his research interests in, particularly, the Psocoptera. As a result, Courtenay did not publish any records of the migrations of the Caper White. However, he and I discussed the migrations of this species at length and we concluded that the main breeding area of this species is that vast area of southern Queensland and New South Wales west of the Great Dividing Range, where larval food plants such as the Warrior Bush *Apophyllum anomalum* F. Muell and the Native Orange *Capparis mitchellii* Lindl (both Capparaceae) grow.

The native food plants occur naturally only north of Griffith, NSW, which poses one of the key questions as to why the migrations seem to be so maladaptive, given that the butterflies often fly in such huge numbers away from potential breeding localities such as, for example, into all of Victoria. The butterflies emerge in large numbers in late October-November, with freshly emerged females soon mated and ready to lay eggs on any suitable food plant they come across. They normally fly in a northeasterly direction but their exact route varies annually, depending on the prevailing winds at the time. A strong westerly can cause them to fly through Canberra and as far eastwards as Sydney and Brisbane and beyond. During years when the westerlies fail to coincide with their migrations, very few Caper Whites may be seen in Sydney.

On 28 November 1969, Courtenay recorded 'a tremendous "invasion"' of Caper Whites on the western side of Lord Howe Island (Smithers 1970a). Reports from Australia indicated that a large-scale migration was taking place in eastern Australia at that time, with the butterflies moving in a northwesterly direction. These were the first Caper White butterflies recorded from Lord Howe Island, suggesting that with appropriate conditions this species is easily blown off course. Specimens were seen on Lord Howe Island for only a few days and the drop in numbers by 30 November suggests that they continued their migratory movement, leaving the island and presumably becoming 'lost at sea'. Similarly, on 24/25 November 1987, I noted large numbers ('a cloud') of Caper Whites coming straight in to the shore off the sea at Surfers Paradise, Queensland, flying just above wave height. They continued up the beach and across the main road. Very few were seen on the 26th and only one on the 27th. Common and Waterhouse (1981) wrote of the Caper White butterfly: 'Immense migratory flights of this species frequently occur in southern Queensland and New South Wales, and sometimes extending into Victoria. ... At Canberra it is not uncommon to see this species flying steadily north to north-east during November'.

Discussion and new observations

The general public tend not to notice migrating butterflies unless the movement is spectacular, such as the migrations of Caper Whites. Large numbers of white butterflies moving in one direction for days on end are difficult to ignore. My first encounter with this phenomenon was in 1963 at the Sydney suburb of Ryde. The migration started as a trickle on 23 November with one butterfly seen at 10.00 h, nine from 11.30–12.30 h and, from 12.45 to 13.45 h, 196 butterflies were recorded over a 15 metre front flying in a NNE direction. This is the equivalent of over 13,000 per hour over a 1 km front. This migration quickly petered out, with one Caper White sighted on 24 November and another on the 29th. A much more spectacular migration of Caper Whites occurred during November 1966. I observed this at both Ryde and Chatswood (another Sydney suburb). All the butterflies were flying in a northerly direction, first noticed on 1 November and extending until 20 December. At its peak on 28 November, I recorded 180+ butterflies over a 25 metre front for just 5 minutes, an estimate of 86,400+ butterflies per km front per hour. It is not unusual for a migration to continue from dawn until dusk suggesting that, in this example, as many as 7 million+ Caper Whites passed through Sydney in one day. Migrations such as this have been observed from Sydney west to the Blue Mountains, a distance of approximately 100 km!

An example of the general public failing to notice migrating butterflies occurred during November 1986, while I and a number of teachers were supervising children at Ryde swimming pool. For some time I watched Painted Lady butterflies, *Vanessa kershawi* (McCoy, 1868), flying south across the pool. After a while I asked the other teachers if they had noticed the migrating butterflies. No, they hadn't and they were astonished when they realised what was happening around them and how unobservant they were.

Since the last of Courtenay's papers on butterfly migration was published (Smithers 1995), I have observed quite a number of migrations, particularly at my daughter's property at Tuchekoi, near Cooroy on the Sunshine Coast, Queensland. There I have recorded 10 species migrating, one not previously recorded and, on occasions, three species migrating in different directions at the same time. On 22 October 2002, from 11.08 to 11.23 h, over a 33 metre front, I observed 23 *Belenois java teutonia* flying in a NW direction, three *Catopsilia pomona* (Fabricius, 1775) flying southeasterly and nine *Elodina angulipennis* (P.H. Lucas, 1852) flying in a SE direction at a height of 1-3 metres. (Two voucher specimens of *E. angulipennis* were collected). Two days previously, at the same locality, there were 54 *B. j. teutonia* flying to the NW, seven *C. pomona* flying to the SE and three *Junonia villida* (Fabricius, 1787) flying to the west.

Also at Tuchekoi, on 25 and 27 December 1993 I observed three species of butterfly in a spectacular southerly migration. Blue Tigers, *Tirumala hamata*

(W.S. Macleay, 1826), Lemon Migrants, *C. pomona* and Pale green Triangles, *Graphium eurypylus* (Linnaeus, 1758) were observed flying over a 50 metre front during four 15 minute sessions over 3 days (Table 1). The migration continued all day on 26 December until a quite violent storm arrived at 1500 h, with the migration continuing on the 27th. The Blue Tigers flew in a leisurely but determined flight, while the Lemon Migrants and the Pale green Triangles flew at a much faster pace. It is interesting to note that 'resident' Blue Tigers were not involved in the migration.

Table.1. Southerly migration of three butterfly species at Tuckekoi, near Cooroy, SE Queensland, on 25 and 27 December 1993. Numbers were recorded flying over a 50 metre front.

Butterfly species	25 Dec.		27 Dec.		Height above ground
	1030-1045 h	1215-1230 h	1530-1545 h	1100-1115 h	
Blue Tiger <i>Tirumala hamata</i>	22	29	11	25	0.5-2 m
Lemon Migrant <i>Catopsilia pomona</i>	9	9	-	21	2-3 m
Pale green Triangle <i>Graphium eurypylus</i>	11	3	9	11	1-3 m
Temperature	29°C	32°C	30°C	29°C	

Many of the butterfly species that migrate also have a return migration but usually in much smaller numbers. The major flights of *B. java teutonia* in October-November are often spectacular, with reports reaching major Sydney newspapers; however, the return flights the following September are numerically very small and may only be observed by alert lepidopterists.

Although Ian Common worked extensively on bogong moth migration, Courtenay was the only person to have recorded butterfly migration in Australia seriously during the past 50 years. He explored what is perhaps the most interesting and least understood aspect of butterfly biology. We owe him a debt of gratitude for his work on Australia's migratory butterflies and other insects and, in particular, his studies of the Monarch, *Danaus plexippus*. Apart from a posthumous paper in this memorial issue (Smithers 2012), it is almost 20 years since his last publication on butterfly migration; thus there is an opportunity for someone to continue to record and publish details of this fascinating phenomenon. Courtenay's paper records of Caper White migrations are maintained in the Australian Museum archives and are available to researchers.

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THERMALS AND BUTTERFLY (LEPIDOPTERA) MIGRATIONS FROM AUSTRALIA TO NEW ZEALAND

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Abstract

Two direct observations of butterflies at high altitudes in thermals are noted, supporting the hypothesis that long distance migration of butterflies between Australia and New Zealand takes place at high altitudes.

Introduction

The arrival of Australian insects in New Zealand from across the Tasman Sea is a well known phenomenon. Perusal of papers such as those of Ramsay (1954, 1971), Ramsay and Ordish (1966), Gibbs (1969), Fox (1978) and Early *et al.* (1995), plus references provided by these authors, give details and discussion of many such arrivals, especially of butterflies. Holloway (1977, 1996) discussed in great detail similar arrivals on Norfolk Island (especially of moths), based on a remarkable long-term light-trapping program carried out by Marge and Fred Jowett. Observations have been recorded of the arrival of the butterflies *Vanessa kershawi* (McCoy) on Norfolk Island (Smithers 1969), *Belenois java teutonia* (Fabricius) on Lord Howe Island (Smithers 1970) and *Tirumala hamata* (W.S. Macleay) on Norfolk Island (Smithers 1995). Tomlinson (1973) discussed meteorological aspects of dispersal of insects across the Tasman Sea and Holloway (1977) discussed possible mechanisms of transport of insects to Norfolk Island. Further afield, recent work on *Danaus plexippus* (Linnaeus) in North America (Calvert 2001) and *Vanessa cardui* (Linnaeus) migrating from North Africa to Europe (Stefanescu *et al.* 2007), has convincingly demonstrated the use of thermals and high altitude synoptic scale winds to assist migration.

Opinions on long-distance butterfly migration over water

There has been some uncertainty, if not reluctance, as to acceptance of the possibility of butterflies undertaking long-distance flights over water from Australia to New Zealand in low temperature, fast-moving, high altitude air streams. There appears to have been greater acceptance that the journey could be made at low levels with wind assistance. Wind assistance is regarded as essential by most authors, because 'refuelling' by nectar intake is not possible over the sea and because of the physiological inability of the insects to fly for the time needed to make the crossing without such help. Johnson (1969) discussed the physiological needs of insects undertaking long-distance flights and suggested that rapid high altitude flight was involved for some of them. Ramsay (1954) pointed out that, during ten days before the recorded arrival of specimens of *Junonia villida* (Fabricius) in New Zealand, 'there were at least three occasions on which these insects could have been carried across the Tasman Sea', implying that they were blown from Australia. The time taken for such a journey was given as 'about 3 days'. Ramsay and Ordish

(1966) discussed weather conditions in relation to an extensive influx of *Hypolimnas bolina nerina* (Fabricius) in 1956, in terms which suggest that the major factor enabling butterflies to make the journey was the wind. They also estimated that 'The time of transit for a *non-active* butterfly being *carried* [my italics in both cases] from the Australian coast near Sydney to New Zealand would have varied between one and four days ...' and noted that 'Many of the butterflies arrived in remarkably good condition and therefore must have had a relatively easy passage.' We find also a suggestion that 'At 10,000 ft, where the wind direction was much more constant, the speed varied between 20 and 50 knots, but mostly remained at near 30 knots. Strong WNW winds occurred near ground level in the Sydney-Newcastle area from 15-18 April and may have carried the butterflies up and out into the trans-Tasman airflow.' The interesting suggestion that winds at higher altitudes might be involved is not followed up, probably because of lack of direct evidence or disbelief that they could survive for long enough at the low temperatures and high altitudes. 'After 20 April the winds became southerly ... Thus, there was less chance of the butterflies being *carried* [my italics] to New Zealand in this manner after 20 April, the period when most butterflies were seen.' Gibbs (1969) recorded an immigration of large numbers of *Vanessa kershawi* in New Zealand in October/November 1968, at the same time as this species was arriving on Norfolk Island (Smithers 1969). Gibbs suggested, on the basis of smoke arriving from bushfires near Sydney, that 'winds at the time of the main 1968 invasions were favourable for the movement of butterflies'.

Smithers (1969), when recording the arrival of what was obviously part of the same migrant population of *V. kershawi* on Norfolk Island, also with smoke from Australian fires, pointed out that the 'air conditions in many parts of eastern Australia were such that strong updraughts from extensive bushfires were common. Over wide areas, therefore, conditions were favourable for the rapid lifting of specimens in flight to heights of 15,000 feet and more. At these heights, winds were easily capable of transporting specimens to Norfolk Island and the passive movement of torpid butterflies could have been quite rapid; certainly a short enough period of time would be involved to permit butterflies to descend unharmed.' It is a frequently observed fact that partly burned leaves and other debris are lifted high during a bushfire and carried a long distance before returning to earth. Clearly, a butterfly raised to high altitudes, where temperatures low enough to induce torpor are encountered, could be carried at the high speeds of high altitude winds for considerable distances before descending to warmer air. The fact that a butterfly was not actively flying would not, alone, necessarily cause its descent.

Tomlinson (1973) discussed five means by which a butterfly might be raised to high altitude. These included convective cloud, thermals, initial lift provided by passage of a cold front, a small 'dust devil' equivalent to a small 'tornado' and the processes of turbulent transfer. When considering the April

1971 *Hypolimnys bolina* immigration into New Zealand, he estimated that temperatures at 1000 metres were from 7-10°C and at 3000 metres they were from -3-0°C. Even if conditions are not cold enough to induce torpor, the wind speeds at high altitudes could carry a flying or gliding butterfly from Australia to New Zealand in a matter of hours providing the specimen remained airborne, something which would not require much action on the part of the insect. It must be remembered that no damage is incurred by an insect which is simply supported by a moving body of air, irrespective of the speed at which the air mass is moving. Nine hours of flying time in a day is not exceptional for a migrant over land in eastern Australia.

Observations of arrivals in New Zealand, Lord Howe Island or Norfolk Island have, of course, all been made at ground level. The assertion is sometimes made that, as arrivals have only been recorded near ground level, high level arrival does not take place. This is an assumption which is difficult to accept when little opportunity has been available to make observations at high levels. A few authors (e.g. Johnson 1969, Smithers 1969, Tomlinson 1973, Holloway 1977) accepted that wind assisted high level travel could be involved in over sea migrations. Such assistance could allow long distances to be covered very quickly, considering that the winds at high altitudes are often very strong, persistent and maintain their direction for long periods. On the other hand, caution in accepting this has been justifiable in view of the lack of direct, positive, observational evidence.

Two instances of direct evidence that butterflies can rise to high altitudes and thereby have the opportunity to enter high level air streams are available. Both have involved 'thermals' as the lifting force. The first, from an unexpected source not likely to be noticed by entomologists (Welch and Welch 1965), originates in an observation made in August 1931 in Germany by W. Hirth, a German pioneer glider pilot. The first to make serious use of thermals at a time when the art of 'soaring' was in its infancy and gliders were slow-moving, Hirth (1938) wrote: 'I was unable to find any new up-currents in my immediate vicinity. However, I suddenly caught sight of some butterflies which had obviously reached that height under thermal influences and I hastened to make use of the same locality.' The observation was made at a height of 2000 ft.

The second observation was made by G. Sutherland (pers. comm.) while paragliding. Paragliders rely on thermals to obtain lift. Thermals frequently carry up debris such as leaves, grass, seeds and other parts of plants. These items are used by the flyers to detect thermals which, unless associated with cloud formations or other visible signs, cannot be detected. Butterflies were encountered (probably *B. java teutonia*) above 6000 ft; they were circling or flying 'aimlessly' in a thermal at Manilla, New South Wales, at the end of November 1997 and it is probable that most of them would have reached altitudes of 10,000 ft if they remained in the thermal. It is significant that low

level migrations of *B. java teutonia* were recorded at several New South Wales localities before and at the same time as the observations in the thermals. These were at Ryde on 1.x.1997 (J.V. Peters), Turrumurra on 7.xi.1997 (C.N. Smithers), Wallis Lake on 11-12.xi.1997 (A.B. Rose), Forster on 15.xi.1997 (A.B. Rose) and between Sydney and Goulburn on 27-28.xi.1997 (A.S. and C.N. Smithers). The last-mentioned was a continuous, sometimes dense migration observed over a distance of 100 km. Although there are no direct records of migration at ground level at Manilla itself at the time of the observation in the thermal, it is obvious from the localities and dates of the recorded migrations that there would almost certainly have been movements in the Manilla district, or nearby, at the time.

Rising with the aid of a thermal is one way which would provide access to a very strong and persistent high altitude wind system. Whether butterflies actively fly upwards once within a thermal or are passively lifted within the thermal is of little importance in the present context. In the case of winds travelling from Australia over the Pacific, butterflies could be moved consistently at speeds well in excess of 100 km/hour above 10,000 ft (*c.f.* Holloway 1977, p. 158, fig. 111 and associated discussion) and greater speeds at higher altitudes. This would enable a butterfly to complete the journey from Australia to Norfolk Island in a matter of hours, depending on the wind speed. It is relevant to note that all species of butterflies which have been recorded as arrivals in New Zealand and Norfolk Island are habitual migrants in Australia. They all cease flight at night and take nectar during their migrations over land. This is not possible when flying over sea but would not be necessary if their journey were fast enough and economical enough in energy consumption.

There are, of course, many records of migrating butterflies being seen at sea at low altitudes. *Tirumala hamata* was seen on 7 April 1995, two days before appearing on both Norfolk Island and New Zealand on 9 April 1995 (Smithers 1995, Early *et al.* 1995). This observation does not preclude the possibility of successful high altitude travel at the same time by parts of the same migrating population. It would depend on the conditions in the area of origin in Australia, which could be very extensive and variable. There is, also, no reason to assume that only one method is 'used' by the butterflies. It does seem, however, with the physiological constraints discussed by Johnson (1969), that fast-moving, long-distance, high level migrating individuals have an advantage and a better chance of successful long distance travel than low-level travellers moving 'under their own steam' across areas where 'refuelling' is not possible. There are many records of individual butterflies and other insects, some of which are small and possessed of very limited energy reserves, having been seen hundreds of miles from land. The turbulence caused by wind changing directions (as in the case of moths arriving on Norfolk Island (Holloway 1977), mentioned below) could well bring down high altitude butterflies before landfall, with the butterflies

making only the final part of the journey at lower altitudes. This would be more likely in the case of New Zealand, where the land mass is much greater than that of Norfolk Island. Whether one or two 'methods' are available for successful long-distance movement will only become known through further observation. In any event, it must be accepted that there will probably be great losses of individuals on any long distance migration low over the sea through physiological failure. Movement within a high level air mass would not require exceptional energy expenditure; as long as the insect remains airborne it could be transported at high speed. A torpid butterfly could be carried for long distances, just as inanimate objects raised by bushfires are carried. Higher level movement is likely to be more economical than low level flight in terms of energy expenditure.

Holloway's (1977, p. 152) data indicated that for Norfolk Island 'Apart from October 1971, when conditions may have been exceptional, rarely does a peak of vagrant arrivals coincide with a period of strong and predominant westerlies.' Such peaks occurred when wind was 'changing from westerly to south-easterly or vice versa' and the moths themselves were taken more frequently in the traps on the eastern side of the island than the west. This suggests an approach from the east into sheltered areas of the island against the predominant westerly wind. The presence of the island near such wind conditions would 'create conditions favouring downfall on Norfolk as distinct from vagrant transport over Norfolk'. As the moths are Australian species they must, however, have originated in Australia. This apparent anomaly can be explained if the moths are using a high level route provided by the almost constant westerly winds which blow at high altitudes, irrespective of the low level wind directions at the time, and are brought down by the turbulence associated with wind direction change at low levels. At low level the winds were easterly and hence the moths were being assisted by easterly winds for the last part of the journey and approached the island from the east. Descent initiated by a zone of turbulence, whether cause by wind change or by presence of a land mass, need not be injurious to the insect.

It may require a different set of circumstances to occur for nocturnal insects, *e.g.* moths, to be lifted initially by thermals, which are essentially diurnal phenomena. Nocturnal migrants could well gain the required initial lift by some other mechanism, such as the 'cold front' method described by Tomlinson (1973). In the past, the hypothesis that butterflies (and other insects) can reach the heights necessary to enable them to be transported rapidly from Australia to New Zealand, Lord Howe and Norfolk Islands (Smithers 1969, Holloway 1977) has rested on somewhat circumstantial evidence. The two observations reported here lend strong, direct observational support to that hypothesis.

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Postscript. The introduction was updated by Albert Orr – Ed.

REVISITING THE PSOCOPTERA (INSECTA) OF BARROW ISLAND, WESTERN AUSTRALIA

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Abstract

Courtenay Smithers recorded five species of Psocoptera on Barrow Island in 1982. Since then, repeated surveys have been conducted as part of environmental impact assessments associated with the Gorgon Project development on Barrow Island. This baseline information on invertebrates is to be utilised as a component of surveillance programs in support of the Gorgon Project's quarantine detection system. These additional surveys on the island have yielded a further 20 species of psocopterans, bringing the total fauna collected to 25 species. This includes the first Australian record of the synanthropic species *Dorypteryx domestica* (Smithers).

Introduction

Courtenay Smithers originally recorded five species of Psocoptera collected over 18 field days on Barrow Island during 1982 (Smithers 1984). Smithers described a new genus and two new species from this collection event, one of which was *Barrowia insularis* Smithers (Fig. 1). This psocid species has not been recorded so far from any other locality in Australia. The initial collection on Barrow Island was the start of the discovery of a surprising diversity of Psocoptera on this arid island, which lies off the northwestern coast of Australia and has become the site of Chevron Australia Pty Ltd's liquefied natural gas development, a part of the Gorgon Project (see acknowledgements). As a result of the environmental impact assessments associated with the development, extensive field surveys were conducted with the aim of providing baseline information on invertebrates. This baseline information is utilised as a component of a surveillance program in support of the Gorgon Project's Quarantine Management System. We present herewith a list of species collected to date on Barrow Island and provide an analysis of species distribution within the island. As data are lacking for the corresponding mainland psocid fauna, it is difficult to place this island fauna into a larger continental context. However, the existence of this body of work will hopefully enable other researchers to gain an understanding of the possible diversity of psocopterans in arid Australia.

This study forms part of a multi-million dollar biosecurity project which provides essential data for protecting Australia's biosecurity. More than 30 taxonomists were involved in identifying invertebrates from the baseline invertebrate survey of Barrow Island (Callan *et al.* 2011), including Courtenay Smithers. It is interesting to reflect that six of the taxonomists are retired scientists and four undertake taxonomic work only in their spare time. The diminishing number of salaried taxonomists in this country is disturbing, particularly considering the advanced age of many of those who assisted us, as evidenced by the sad passing away of our friend, Courtenay Smithers.

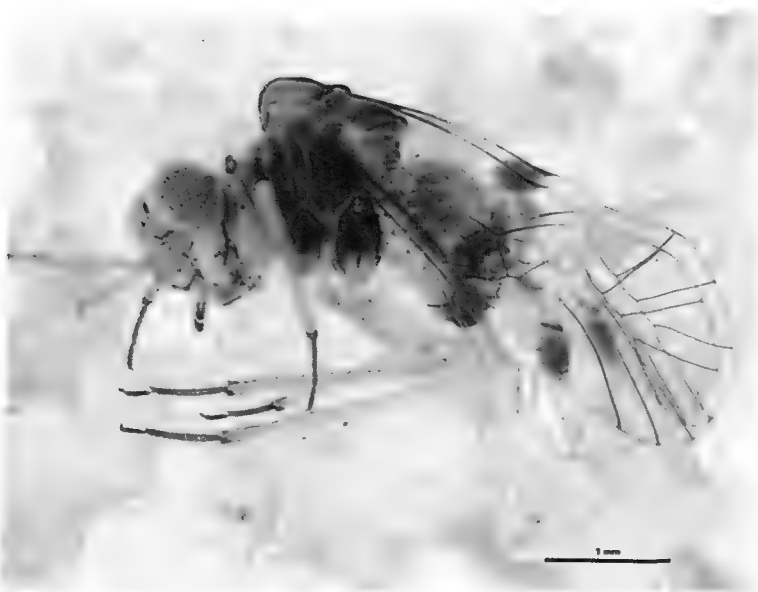


Fig. 1. Lateral view of a male specimen of *Barrowia insularis* Smithers from Barrow Island. This psocid species was collected by Courtenay Smithers and described in Smithers (1984).

Materials and methods

Barrow Island is located approximately 60 km from the North-West coast of Australia and is 234 km² in extent. The island receives, on average, 300 mm of rainfall annually. However, this is highly variable from year to year, with some years receiving less than 100 mm (e.g. 2009) and others receiving more than 700 mm (e.g. 1973) (BOM 2012). The majority of this rain falls in the hot, humid summer months of February and March, with a smaller amount falling in the cooler months of July and August. The most dominant vegetation complex on the island is *Triodia* hummock grasslands (Fig. 2). These are interspersed with *Acacia* stands and small clumps of *Ficus* trees. Mangroves (*Avicennia* and *Rhizophora*) occur in small patches along the coast (RPS Bowman Bishaw Gorham and Mattiske Consulting 2005).

Intensive surveys of invertebrates were carried out on Barrow Island between 2006 and 2007 and the results of these surveys have been reported in Callan *et al.* (2011), with species lists provided as an electronic appendix. This report recorded 19 species of Psocoptera in ten families. A variety of methods were used to capture invertebrates from the litter, ground surface, vegetation and other structures in a range of habitats distributed across the island (Figs 3-5). An extensive description of these methods and sites can also be found in Callan *et al.* (2011). All specimens from these surveys are lodged in the Australian Museum, with voucher reference specimens held in Curtin University Entomology Museum.



Figs 2-5. Environment and collecting techniques: (2) the east coast of Barrow Island is typified by low, spinifex covered dunes and sandy beaches with tidal flats – in the distance are five holding tanks for the oil that is pumped from below the island; (3) one of the collecting methods for invertebrates is night hand collection – many night-active flying insects are collected with this method; (4) another collection method commonly used for Psocoptera – beating or sweeping the vegetation into a collection tray or net often yields a number of invertebrate orders; (5) a leaf blower in suction mode is used to vacuum small invertebrates inhabiting vegetation – as spinifex is dense and spiky and unpleasant for hand collection, the blower vac is an effective method for collecting psocopterans within these tussocks.

Psocoptera were collected from 12 undisturbed native vegetation sites (classified as GP sites) in two seasons in 2006. The first collection was after the hot wet season in March and the second was carried out after the cooler dry season in September. Psocoptera were also collected from 13 disturbed habitat sites (classified as NIS sites) in 2006, which were visited again in 2007. The latter sites were chosen to see whether any non-indigenous species were present. A slightly modified collection protocol was carried out for the disturbed habitats to take into account the built environment present at these sites.

Table 1. The 25 Psocoptera species or morphospecies that have been collected from Barrow Island to date, in both native vegetation (N), disturbed habitats (D) and the built environment (B). Asterisked species were recorded by Smithers (1984) and species with a hash are cosmopolitan species found opportunistically since 2007. All species were identified by C. Smithers except *Dorypteryx domestica* and *Liposcelis bostrychophila*, which were identified by C. Taylor.

Family	Genus and Species	Habitat	Vegetation type
Amphientomidae	Amphientomid 1 sp. H	N, D	Spinifex on limestone ridge and floodplain
Caeciliusidae	<i>Caecilius</i> sp. T *	D	Rehabilitated site
Ectopsocidae	<i>Ectopsocus</i> nr. <i>erosus</i> (Enderlein)	D	Rehabilitated site
	<i>Ectopsocus</i> sp. B	N, D, B	Widespread on island
	<i>Ectopsocus</i> sp. N	N, D, B	Spinifex on limestone ridge and floodplain, coastal dunes
	<i>Ectopsocus</i> sp. P	N, B	Spinifex on limestone ridge
	<i>Ectopsocus</i> sp. R	D, B	Barge landing and rehabilitated sites
	Unknown Genus sp. Q	B	Camp and Warehouse
Lepidopsocidae	<i>Pteroxanium</i> sp. A	N, D, B	Widespread on island
Liposcelididae	Liposcelid 1 sp. D	N	Coastal dunes
	Liposcelid 2 sp. E	N	Coastal dunes
	Liposcelid 3 sp. J	N, B	Coastal dunes, spinifex on limestone ridgetop
	Liposcelid 4 sp. K	N, B	Spinifex on limestone ridgetop
	Liposcelid 5 sp. L	N	Spinifex on limestone floodplain
	<i>Liposcelis bostrychophila</i> Badonnel #	B	Camp
	<i>Liposcelis entomophila</i> (Enderlein) *	B	Camp
	<i>Liposcelis</i> sp. O (complex)	N, D, B	Widespread on island
Peripsocidae	<i>Peripsocus fici</i> Smithers *	B	Camp
Philotarsidae	Philotarsid 1 sp. G	N	Spinifex on limestone ridge
Pseudocaeciliidae	<i>Cladioneura foliata</i> Smithers *	N, D	Coastal dune, spinifex on limestone ridgetop
Psocidae	<i>Barrowia insularis</i> Smithers *	N, D, B	Widespread on island
Psyllipsocidae	<i>Dorypteryx domestica</i> Smithers #	B	Camp
Trogiidae	? <i>Lepinotus</i> sp. F	N	Spinifex on limestone floodplain
	? <i>Lepinotus</i> sp. I	N, D	Coastal dunes
indet.	Gen. n. sp. M	N	Coastal dunes

Data were analysed as presence/absence. The collection protocol resulted in large volumes of invertebrates being collected, which meant that counting individuals was not time effective. For the GP sites, seasonal differences (wet/dry) in species richness were tested using an independent t-test. This was also done for species richness from two of the the collection periods (2006/2007) of the NIS sites. The statistical program PASW Statistics 18.0.2 was used to carry out this analysis. The GP and NIS site-by-species matrices were treated separately, as the collection protocols were not comparable. The species matrices from each season or survey were combined and a similarity matrix calculated for each site-by-species matrix using a Bray-Curtis similarity index (Bray and Curtis 1957). Each similarity matrix was then utilised to create a non-metric multidimensional scaling (NMDS) of the data to provide a visual presentation of how similar each site's species assemblage was in comparison with another site. These analyses were carried out using PRIMER-E v6.1.11.

Results

The 25 psocopteran species collected on Barrow Island from both native vegetation and disturbed habitat sites are listed in Table 1. The two most speciose families on the island are the Liposcelididae and Ectopsocidae. Included in the table are three synanthropic species that have been collected during surveys of the built environment on the island. These are *Liposcelis bostrychophila* Badonnel, *Liposcelis entomophila* (Enderlein) and *Dorypteryx domestica* (Smithers). *Liposcelis bostrychophila* and *D. domestica* have been collected in the built environment (Chevron pers. comm.) since the GP and NIS studies concluded. However, *L. entomophila* has not been collected since its first collection on the island in 1982 (Smithers 1984). Images of 21 of the psocopteran species of Barrow Island are publicly available and can be accessed at the website [www.padil.gov.au/barrow-island].

There appeared to be no significant difference between seasons for species richness at each GP site ($P > 0.1$). Species assemblage analysis did not yield any discernible trends in terms of similarity between sites, even when the assemblages from the two seasons were combined. Hence, the results from the NMDS are not displayed. For the NIS sites, no significant difference in species richness could be determined between the two surveys in 2006 and 2007 ($P > 0.1$). Here too, no discernible trends in species assemblages could be observed within the NIS sites.

Discussion

There are 252 described species of Psocoptera listed for Australia by Smithers (1996a), which is undoubtedly an underestimate due to the under-sampling of the northwestern part of the country (Schmidt and New 2008). For instance, Smithers (1996a) listed only four species of Liposcelididae for this area, fewer than present on Barrow Island alone (three further species of this family were recorded in the Western Australian wheatbelt by Smithers

1996b). Considering the remoteness of the northwestern part of Australia, the Barrow Island invertebrate fauna has been relatively well studied. Barrow Island has only slightly lower species diversity than other Australian offshore islands. Psocopteran collections on Lord Howe Island yielded 27 species (Smithers 2007) and 40 species were identified accumulatively on the four larger Bass Strait Islands (Cole *et al.* 1989).

The collection of an undescribed species of Amphientomidae is of interest as this is a rare family in Australia. Only three species have been described previously from Australia, all from single specimens (Smithers 1989, New 1994). In contrast, the Barrow Island amphientomid is known from several specimens, with both macropterous and brachypterous individuals present. A description is currently in preparation.

Psocoptera are generally associated with microflora (*e.g.* fungi, lichen, algae) and the highly seasonal arid environment on Barrow Island is not conducive to supporting a diverse psocopteran fauna. Despite collecting only five species, Smithers (1984) seemed to accept that such a low number of species was to be expected from such an arid island. The collection of an additional 18 species between 2006 and 2007 shows that a large number of species can be overlooked when only one method of collection is utilised. However, the island's highly seasonal environment and the generally accepted view that Psocoptera are easily dispersed by wind (New 1987) can also complicate species richness assessments.

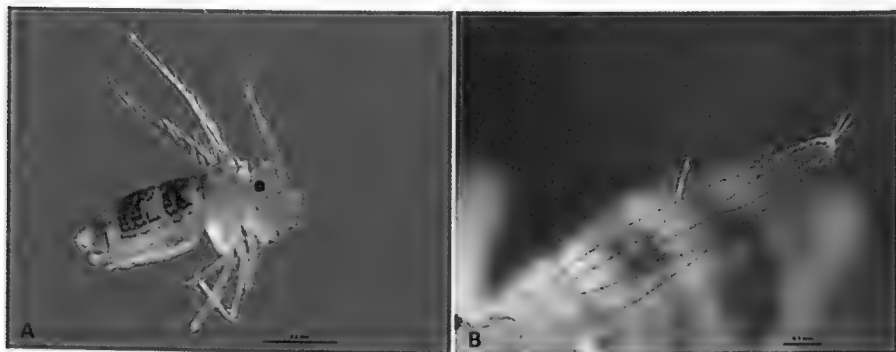


Fig. 6. *Dorypteryx domestica* female collected in accommodation block on Barrow Island: (a) lateral view; (b) close-up of forewing showing venation.

To date, only three widespread synanthropic species have been identified from the island. One of these, *Dorypteryx domestica* (Fig. 6), has not previously been recorded from Australia but is widely distributed, with records from Europe, North America and Africa (Mockford 1993). Their small size means that they easily escape detection in regions where they are

not previously known and their presence in Australia is not unexpected (T.R. New pers. comm.).

With few exceptions, *Dorypteryx* species are known almost entirely from synanthropic environments. Another species, *Dorypteryx longipennis* Smithers, was first described from Australia as a quarantine intercept (Smithers 1991), while *D. longipennis* and *D. pallida* Aaron are known to have cosmopolitan distributions similar to that of *D. domestica* (Lienhard and Schneider 1993, Mockford 1993).

Liposcelis bostrychophila and *L. entomophila* are also both widely distributed cosmopolitan species (Mockford 1993). Despite regular pest inspections of the built environment on Barrow Island and quarantine surveillance of the surrounding vegetation, these species are collected very rarely. *Liposcelis entomophila* is only known from its original collection in 1982. It is believed that these known cosmopolitan species are not permanent inhabitants of the built environment on Barrow Island and only occasionally re-occur within the man-made structures, possibly being blown over or being carried from the mainland. Their small size makes Psocoptera excellent wind dispersers, even wingless species, and *Liposcelis* specimens have been collected in wind traps on ships up to more than 1100 km from shore (Thornton and Harrell 1965). For a comparison with regards to synanthropic species, Lord Howe Island has four well known cosmopolitan species out of its 27 recorded species (Smithers 2007) and Norfolk Island has seven cosmopolitan species out of 21 (Smithers *et al.* 1999).

The fact that there did not appear to be any seasonal or annual collection differences in the species richness within the native vegetation and disturbed area sites perhaps points to a more stable fauna for the island. Also, the high ratio of un-named species to named species demonstrates the potential uniqueness of the fauna. Smithers was not able to put names on the majority of species from Barrow Island, which would indicate a high level of potential endemism either for the island itself or the north-west of Australia in general.

Acknowledgements

The authors thank Chevron Australia for on-island support with logistics and the Gorgon Joint Venture Partners for financial support to undertake the project. The Gorgon Project is operated by an Australian subsidiary of Chevron and is a joint venture of the Australian subsidiaries of Chevron (approximately 47%), ExxonMobil (25%) and Shell (25%), Osaka Gas (1.25%), Tokyo Gas (1%) and Chubu Electric Power (0.417%). Shae Callan, Karl Edwards, Karen Edward, Rebecca Graham, Tim Lardner, Dr Anita Lyons, Morgan Lythe, Natalie Randall, Brad Scanlon and Dusty Severtson all assisted the project, either in the field and/or in the laboratory. Professor Timothy New confirmed the identification of *Dorypteryx domestica*.

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**THAUMASTOPSALTRIA SMITHERSI, A NEW CICADA FROM
NORTHERN QUEENSLAND WITH AN ANALYSIS OF ITS
PHYLOGENETIC RELATIONSHIPS (HEMIPTERA: CICADIDAE:
CICADETTINAE: CHLOROCYSTINI)**

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Abstract

Thaumastopsaltria smithersi sp. n. is only the second species of *Thaumastopsaltria* Kirkaldy to be recorded from Australia. Its distinguishing features are documented together with notes on its distribution and habitat. A revised phylogeny for the genus is provided and the phylogenetic relationships of *T. smithersi* discussed.

Introduction

The genus *Thaumastopsaltria* Kirkaldy includes seven species found in Waigeo and Misoöl Islands, mainland New Guinea, D'Entrecasteaux Islands, New Britain, Umboi Island, northern Australia and, doubtfully, from Buka Island and Bougainville (de Boer 1992). The genus has recently been redefined and its distinguishing features summarised (Moulds 2012). *Thaumastopsaltria* belongs to the tribe Chlorocystini Distant, 1905 and a detailed analysis of relationships within the Chlorocystini was provided by de Boer (1995a).

The single previously described Australian species of *Thaumastopsaltria*, *T. globosa* (Distant), is known from along the eastern margin of Cape York Peninsula from Banks Island in Torres Strait to Daintree, and from Groote Eylandt, Northern Territory (Moulds 1990, as *T. glauca*, a synonym of *T. globosa*). A second species is described here, with its distribution confined to the rainforests south from Cooktown and with only a marginal overlap with that of *T. globosa*. Phylogenetic relationships of this new species are discussed below and a revised phylogeny for the genus is provided.

Terminology for morphological features follows Moulds (2005, 2012) and for higher classification that of Moulds (2005). The following abbreviations have been used for collections housing specimens: *AE*, collection of A. Ewart, Golden Beach; *AM*, Australian Museum, Sydney; *ANIC*, Australian National Insect Collection, Canberra; *LP*, collection of Lindsay Popple, Brisbane; *MSM*, collection of M.S. Moulds, Kuranda; *ML*, collection of Mark Lane, Atherton; *QM*, Queensland Museum, Brisbane.

***Thaumastopsaltria smithersi* sp. n.**

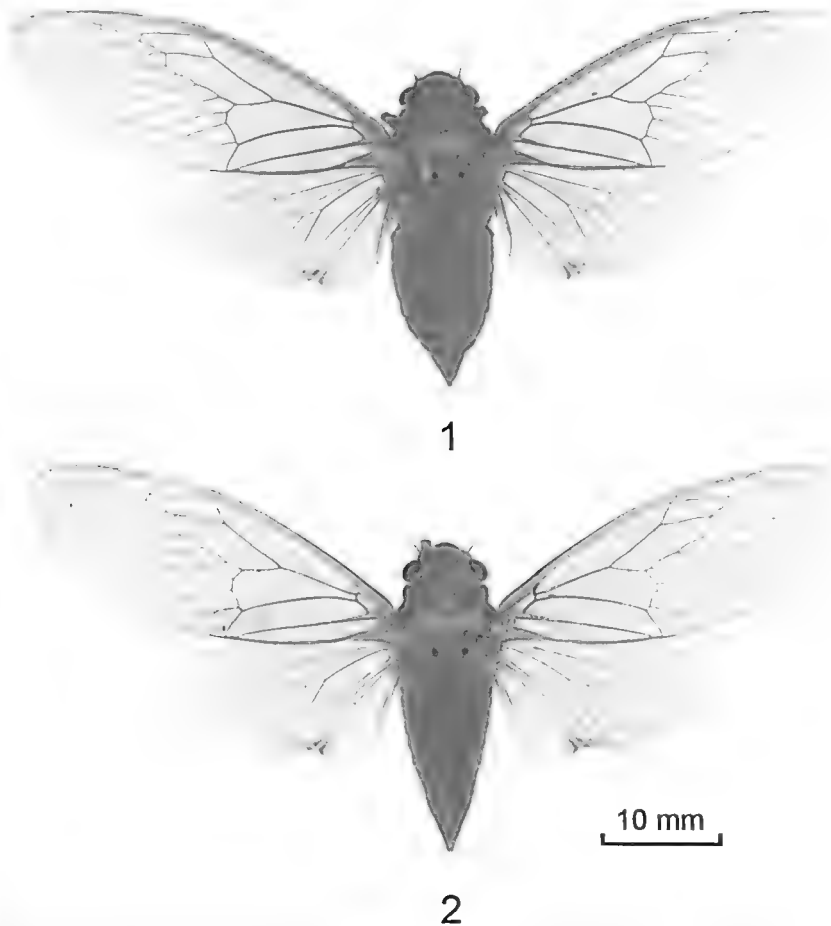
(Figs 1-9)

Type material. Holotype ♂, QUEENSLAND: 6 Victor Pl., Kuranda, 16°48'50"S 145°38'36"E, 18.xii.2008, Hill, Marshall, Moulds (AM). *Paratypes* (all northeastern Queensland): 1 ♂, 2 ♀♀, Kuranda, 10.i.1983, 7.ii.1982, 3.iii.1982, W.N.B. Quick; 1 ♀, 16.08S 145.26E, 2.5 km WSW of Noah Head, Cape Tribulation NP, 'Marrdja Botanical Walk', 2.xi.1993, D.C.F. Rentz & W.L. Lowe, stop 11 (ANIC); 1 ♂, 1 ♀, nr

The Crater, 20 km S of Atherton, 21,29.xi.1987, D.A. Lane (AE); 1 ♂, 1 ♀, The Creator, near Herberton, 3.i.1967, D.K. McAlpine & G. Holloway (AM); 1 ♂, 1 ♀, nr The Crater, 20 km S of Atherton, 29.xi.1987, D.A. Lane (LP); 5 ♂♂, 1 ♀, Longlands Gap, 20 km south Atherton, 19.xii.2001, D.A. Lane (ML); 1 ♀, Mt Hartley, nr Rossville, S of Cooktown, 1.i.1984, M.S. & B.J. Moulds; 1 ♀, Gap Ck, Mt Finlayson Rg, S of Cooktown, 10.ii.1982, M.S. & B.J. Moulds; 2 ♂♂, Windsor Tableland, NW of Mossman, 16.i.1988, M.S. & B.J. Moulds; 1 ♀, Mt Lewis via Julatten, 21.xii.2009, Gilligan & Epstein; 5 ♂♂, 7 ♀♀, Kuranda (Top of the Range), 19 Butler Dr., 335 m elev., 16°48'S 145°38'E, 15-30.x.2004, 1-15.xi.2004, 1-15.xi.2006, 1-15.xii.2005, 1-15.xii.2007, 16-31.x.2008, 1-15.xi.2008, 16-30.xi.2008, 1-15.xii.2008, 1-15.ii.2009, 1-15.i.2010, D.C.F. Rentz; 1 ♀, Kuranda, 10.xi.1987, 7.xii.1987, J. Hasenpusch; 1 ♂ (genitalia prep. THE3), Kuranda, xii.1985, R. Straatman; 1 ♂, Kuranda, 5.ii.1987, R. Straatman; 1 ♂, Whitfield Rg, nr Cairns, 2.xii.1986, M.S. & B.J. Moulds; 1 ♂, Hugh Nelson Range, 20 km S of Atherton, 18.xi.1990, D.A. Lane; 2 ♂♂ (one genitalia prep. THE4), 2 ♀♀, nr The Crater, 20 km S of Atherton, 21,29.xi.1987, D.A. Lane; 1 ♂, The Crater, Atherton Tableland, 24.xii.2009, Gilligan & Epstein; 1 ♂, 'Chowchilla', Westcott Rd, Topaz, approx. 15 km SSE of Malanda, 18.xi.1990, W.T. Cooper; 1 ♀, 'Chowchilla', Westcott Rd, Topaz, approx. 15 km SSE of Malanda, 25.xi.2000, W.T. Cooper; 1 ♀, Bartle Frere, 27.xii.2000, A. Polak; 1 ♀, Ravenshoe, i.1986, S. Lamond; 4 ♂♂ (one genitalia prep. THE2), 3 ♀♀, Polly Ck, Garradunga N of Innisfail, 20.xi.1987, 23.xi.1996, 20,23.x.2006, 9.i.2008, 12.xi.2008, J. Hasenpusch (MSM); 1 ♂, 1 ♀, Kuranda (Top of the Range), 19 Butler Dr., 335 m elev., 16°48'S 145°38'E, 1-15.xii.2007, 1-15.xii.2008, D.C.F. Rentz; 1 ♂, Kirrama Range, Douglas Ck Rd, 800 m, 7-12.xii.1986, Monteith, Thompson & Hamlet (QM).

Distinguishing features. Distinguished from all other Australian cicadas in having 12 apical cells in the forewing (11 or 13 if aberrant, but usually so only in one wing) and no subapical cells. Distinguished from *T. globosa* by the pair of black thoracic spots located near the ends of the anterior arms of the cruciform elevation highlighting the scutal depressions (absent on *T. globosa*), and the widely spaced ocelli that have the distance between them considerably greater than their diameter (those of *T. globosa* have the ocelli close together, closer than their diameter). The male aedeagus is unique within *Thaumastopsaltria* in having the apical gonopore sloping backwards along the dorsal surface and terminating in a small dorsal crest (Fig. 5); other species have a gonopore either sloping backwards along the ventral surface or not sloping at all so that the aedeagus in lateral view has the apex square.

Description. Male (Figs 1, 3-8). Head light green, tending pastel in tone, paler below than above, about as wide as lateral margins of pronotal collar; eyes tan tending a little reddish; ocelli small and widely separated with the distance between them much greater than their diameter; postclypeus and anteclypeus a little paler than dorsal surface of head; postclypeus in lateral view barely obtusely bent; in ventral view (Fig. 3) rostrum very pale brown with darker tip, reaching near to bases of hind coxae. Thorax similar in colour to head. Pronotum sometimes with hints of very pale orange centrally; prothoracic collar mostly very pale orange across dorsal surface but otherwise light green; paratnota rounded. Mesonotum usually with a very



Figs 1-2. *Thaumastopsaltria smithersi* sp. n.: (1) holotype male, dorsal view; (2) paratype female, 19 Butler Drive, Kuranda, dorsal view.

pale orange fascia either side of midline aligned with distal ends of anterior arms of cruciform elevation; scutal depressions highlighted as black spots. Metathorax similar in colour to pro- and mesothorax. Wings (Figs 1-2) hyaline. Forewing with 12 apical cells (often 11 or 13 if aberrant but if so usually only in one wing); veins very fine, costal margin very pale yellowish orange, veins otherwise pale green or black. Hind wing with seven apical cells; distinct infuscation at distal ends of veins 1A and 2A spreading onto wing margin; veins mostly very pale green but some pale brown or very pale orange. Legs very pale green becoming very pale yellowish brown distally from about mid length of tibia. Timbals (Fig. 4) with seven long ribs spanning width of timbal plate and seven short ribs, the ribs occupying most

of timbal area; timbal plate narrow and mostly concealed. Opercula (Fig. 3) very pale green, covering a little less than half tympanal cavity, transversely broad and broadly rounded towards midline, clearly separated exposing most of sternite I. Abdomen dorsally similar in colour to head and thorax, paler ventrally, sometimes tending very pale bluish green and often with hints of very pale brown around distal midline and sternite VIII.

Genitalia (Figs 5-8). Pygofer in ventral view (Fig. 8) with cavity tapering towards base, in some individuals forming a distinct 'V' shape; pygofer upper and basal lobes in lateral view (Fig. 7) weakly developed and broadly rounded. Claspers well developed, claw-like, their apices slightly diverging and slightly down-turned. Uncus degenerate, barely discernible. Aedeagus with theca (Fig. 5) almost cylindrical, gradually tapering towards apex, straight or gently curved in a shallow arc; gonopore apical but sloping backwards along dorsal surface of theca, the opening at its proximal end narrowing and forming a small crest in lateral view; basal plate almost rounded in dorsal view (Fig. 6), stepped in lateral view (Fig. 5).

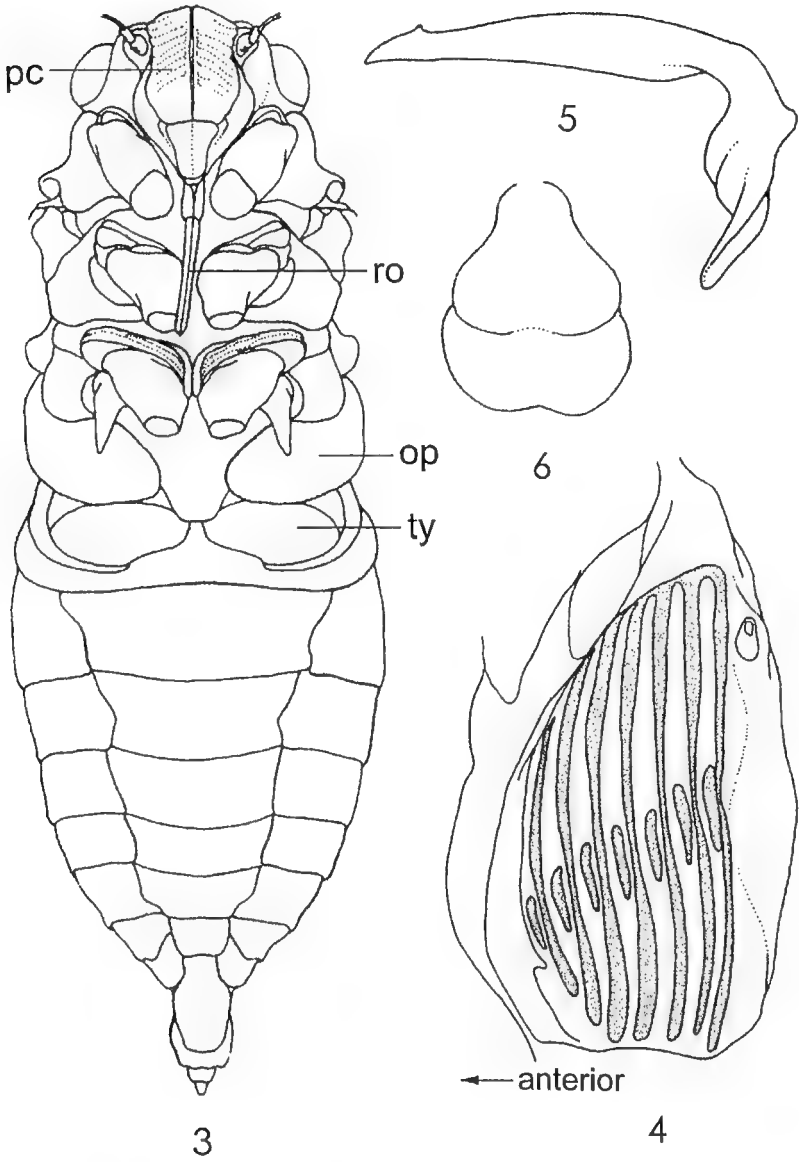
Female (Fig. 2). Similar to male. Abdominal segment 9 uniformly pale green, along dorsal midline just a little longer than abdominal tergites 7 and 8 combined; ovipositor sheath terminating about level with caudal beak; caudal beak sharply pointed.

Measurements. Range and mean (in mm) for 10 males and 10 females, including smallest and largest available specimens. *Body length*: male 21.4-27.2 (25.1); female 21.0-25.5 (23.3). *Head width (including eyes)*: male 5.7-6.7 (6.2); female 5.9-6.9 (6.5). *Pronotum width (across lateral angles)*: male 6.7-8.8 (7.7); female 6.7-8.7 (7.9). *Forewing length*: male 28.3-37.3 (32.3); female 27.5-35.1 (31.4). *Forewing width*: male 10.2-13.8 (11.9); female 9.7-13.1 (11.5). *Forewing ratio width/length*: male 2.7 ± 0.1 ; female 2.7 ± 0.1 .

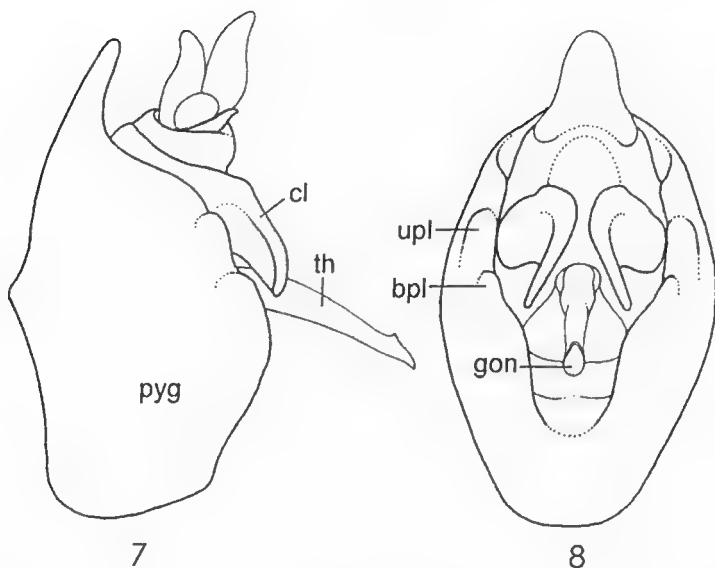
Etymology. Named in memory of Dr Courtenay Smithers, a friend and mentor, past Curator of Insects, Principal Curator and Deputy Director of the Australian Museum. Courtenay had broad interests in entomology covering most Orders and his extensive publications contributed significantly to our knowledge of Australian insects.

Song. Singing occurs at dusk and is a high pitched, whistle-like, continuous call.

Distribution and habitat (Fig. 10). Northeastern Queensland, south from Mount Hartley (south of Cooktown near Rossville) to the Kirrama Range (north-west of Cardwell). Most records are from mountain areas between about 300 m and 800 m but there are records from much lower altitudes, including Gap Ck south of Cooktown at 40 m, Marrdja Botanical Walk, Cape Tribulation at 21 m and Polly Ck, Garradunga at 25 m. The species has been found only in rainforest. Adults have been taken from mid October to mid February but are most common during November and December.



Figs 3-6. *Thaumastopsaltria smithersi* sp. n.: (3) ventral view of body; (4) left timbal showing ribs; (5) aedeagus in lateral view; (6) basal plate of aedeagus in dorsal view, apex at bottom. *op* operculum; *pc* postclypeus; *ro* rostrum; *ty* tympanum.



Figs 7-8. *Thaumastopsaltria smithersi* sp. n., male genitalia: (7) lateral view; (8) ventral view with claspers spread apart. *bpl* basal pygofer lobe; *cl* clasper; *gon* gonopore of theca; *pyg* pygofer; *th* theca of aedeagus; *upl* upper pygofer lobe.

Phylogenetic relationships

De Boer (1995a) presented a cladistic analysis based on morphological characters and incorporating all known species of the tribe Chlorocystini. He found 600 equally parsimonious trees. The 50% majority rule tree for these 600 trees was found to contain nearly all previously recognized genera and species groups as monophyletic groups and was chosen by de Boer as the preferred tree showing relationships. De Boer's cladistic analysis has been adopted here to determine the phylogenetic position of *T. smithersi* sp. n. within the genus *Thaumastopsaltria*. A cladogram was reconstructed from de Boer's data set retaining only those characters suggesting phylogenetic relationships within *Thaumastopsaltria* and the outgroup. De Boer found that species of the genus *Mirabilopsaltria* de Boer were sister to those of *Thaumastopsaltria*. *Mirabilopsaltria globulata* de Boer and *M. humilis* (Blöte) were chosen as outgroup taxa. Character and state numbers used by de Boer (1995a) were retained to allow direct comparison with his analysis.

Data were analysed using the heuristic search parsimony algorithms implemented with PAUP* version 4.0b2 (Swofford 1998). Tree searches utilized the tree bisection reconnection algorithm (TBR) conducting 1,000 random addition searches (RAS) starting from random trees; other settings were left at their default values. All characters were unweighted and all multistate characters were treated as unordered. Unknown character states

were scored as '?'. The matrix of species and assigned states is given in Table 1, followed by the characters and character states used, adopted from de Boer (1995a) using his character numbers and states but with minor modification as stated in the notes below relevant characters.

Table 1. Character matrix for the eight known species of *Thaumastopsaltria* and two species of *Mirabilopsaltria* used in the parsimony analysis (from de Boer 1995a). Missing data and character states unknown are scored as '?' Character numbers are those used by de Boer in his larger analysis of the Chlorocystini [reading downwards in heading]. However, character states have been renumbered sequentially from zero for the purpose of the current analysis in order to elucidate plesiomorphic states.

Species	00000	00000	00000	00011	11111	111
	01122	33345	66667	89900	22344	555
	52724	23514	15695	20503	09125	023
<i>Mirabilopsaltria humilis</i> (Blöte)	00000	00000	00000	00000	00000	000
<i>Mirabilopsaltria globulata</i> de Boer	00001	11110	10000	00011	00000	010
<i>Thaumastopsaltria adipata</i> (Stål)	10110	0120?	01012	00111	10100	0??
<i>Thaumastopsaltria pneumatica</i> de Boer	11102	01201	01011	01111	10101	020
<i>Thaumastopsaltria spelunca</i> de Boer	10112	11110	10011	11110	02211	120
<i>Thaumastopsaltria globosa</i> (Distant)	10102	11102	11112	11100	02211	121
<i>Thaumastopsaltria sicula</i> de Boer	10100	00010	10011	01100	02011	120
<i>Thaumastopsaltria lanceola</i> de Boer	10102	11000	01112	10100	01002	021
<i>Thaumastopsaltria sarissa</i> de Boer	11102	11000	01112	11101	01001	020
<i>Thaumastopsaltria smithersi</i> sp. n.	11103	00201	11?12	10101	02020	201

Characters and character states

005. *Postclypeus* in lateral view: (1) not swollen; (4) protruding in obtuse angle.
012. *Distance between lateral ocelli*: (1) about equal to distance between lateral ocellus and eye; (2) generally slightly larger than distance between lateral ocellus and eye.
017. *Paranotum (anterolateral side of pronotal collar)*: (1) rounded; (4) forming continuous ridge.
022. *Proximal spine of foreleg*: (1) not shorter than distance to middle spine; (2) distinctly shorter than distance to middle spine.
024. *Colour of forewing*: (1) hyaline, completely without colour; (2) opaque greenish or reddish; (3) slightly reddish but still hyaline; (5) slightly greenish but still hyaline.

NOTE: De Boer listed four states for this character but his state 4 was not relevant to this analysis and is omitted. However, another state is here added (state 5) to accommodate the unique forewing colour of *T. smithersi*.

032. *Subapical cells of forewing*: (1) absent; (2) present but not forming a continuous band.

033. *Base of first apical area of forewing*: (1) distally of base of third apical area; (3) distinctly proximally of base of third apical area.
035. *Number of apical cells in hind wing*: (1) six; (3) six or seven; (4) seven or more.
NOTE: It is not clear why de Boer did not designate discrete character states. Examination of material available to me suggests that some species have either six or seven hind wing apical cells (often on the same specimen), while other species consistently have either six or seven or more; this is the presumed interpretation adopted here when scoring *T. smithersi*.
041. *Timbal cavity*: (1) broad; (2) narrow.
054. *Distal part of female operculum*: (1) rectangular oblong; (2) trapezoid; (3) narrow sickle-shaped.
061. *Second tergite of male*: (1) forming a distinct ridge along timbal cavity; (2) not forming a distinct ridge along timbal cavity.
NOTE: The scoring of this character had been accidentally reversed in de Boer (1995a).
065. *Male auditory capsule*: (1) swollen and protruding; (2) not swollen and not protruding.
066. *Male pygofer and 9th sternite*: (1) resting on 8th sternite; (2) elevated relative to 8th sternite.
069. *Male pygofer*: (1) not curved to ventral position; (2) curved to ventral position on abdomen.
075. *Apex of male dorsal beak*: (2) rounded; (3) truncate or weakly concave; (5) broadly rounded.
NOTE: The scoring of *T. smithersi* for these subjective character states was done by comparing the dorsal beak of *smithersi* with other available material and adopting the scoring of the most similar species.
082. *Protuberance on lateral lobe of male pygofer*: (1) not triangularly swollen; (2) triangularly swollen.
090. *Male pygofer*: (1) not swollen at ventral margin; (2) swollen at ventral margin.
095. *Ventral half of male pygofer opening*: (1) triangular and pointed; (2) broad and rounded.
100. *Clasper*: (1) strongly bent and hook-shaped; (2) nearly straight and posteriorly directed.
103. *Clasper*: (1) parallel; (2) diverging towards apices.
120. *Dorsal edge of clasper*: (1) not curved around aedeagus; (5) globularly rounded.
129. *Clasper*: (1) without ventromedial protuberance; (2) with broad and laminiform ventromedial protuberance; (3) with narrow and spiny ventromedial protuberance.
131. *Clasper*: (1) without lateral process; (2) with lobate lateral process; (3) with lateral thorn.
142. *Apical part of aedeagus*: (1) not abruptly narrowing; (2) abruptly narrowing and upcurved; (4) abruptly narrowing on dorsal surface.

NOTE: De Boer listed three states for this character but state 3 was not relevant to this analysis and is omitted. However, another state is here added (state 4) to accommodate the unique aedeagus of *T. smithersi*.

- 145. *Aedeagus*: (1) without dorsal crest; (2) with single dorsal crest; (3) with paired dorsal crests.
- 150. *Aedeagal pore*: (3) apically pointed but not widening proximally; (5) rounded; (6) apically wide and narrowing proximally.

NOTE: An additional state (state 6) is here added to accommodate the unique aedeagus of *T. smithersi*.

- 152. *Ovipositor sheaths*: (1) reaching to apex of dorsal beak; (2) reaching just beyond apex of dorsal beak; (3) reaching far beyond apex of dorsal beak.
- 153. *Apex of female dorsal beak*: (1) sharply pointed; (2) broadly rounded.

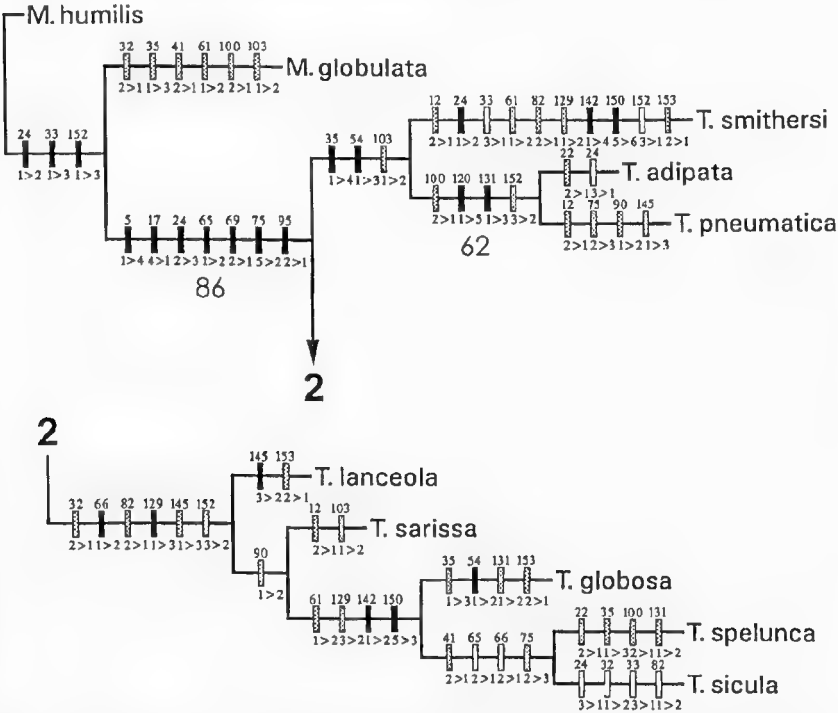


Fig. 9. The single most parsimonious tree derived using the procedures described in the text above (length 66, CI 57, RI 61) from an analysis of all *Thaumastopsaltria* species, employing *Mirabilopsaltria humilis* and *M. globulata* as outgroups, with all characters unordered and equally weighted. Numbers at nodes are bootstrap values >50% from 1,000 replications. Character transformations (generated using Clados) are represented by black bars = non-homoplasious forward changes; grey bars = homoplasious forward changes; and white bars = reversals (whether homoplasious or not). The analysis was run using the data set in Table 1 and state numbers modified (after analysis) to correspond with those used by de Boer (1995a).

Results from running de Boer's (1995a) reduced data set produced three equally parsimonious trees. However, by omitting de Boer's homoplasious character (character 103) from the analysis only one shortest tree was obtained. This tree was identical in topology to de Boer's 50% majority rule tree for the genus *Thaumastopsaltria*. *T. smithersi* sp. n. was then scored and the data added to the data set and the analysis re-run. Three additional character states were added to accommodate the variant forewing colour of *T. smithersi* (state 3 in character 24) and unique morphology of the aedeagus (state 2 in character 142 and state 2 in character 150) (Table 1). Three equally parsimonious trees were obtained but the relationships of *T. smithersi* were largely inconclusive. However, by again eliminating de Boer's character 103, just a single tree (Fig. 9) resulted, which was fully resolved and topographically similar to de Boer's 50% majority rule tree.

Although the single tree obtained here agrees with that of de Boer's 50% majority rule tree, it should be kept in mind that both trees are based on the same data set. Only the node distinguishing *Thaumastopsaltria* and one internal node are well supported statistically. Molecular data is currently unavailable for *Thaumastopsaltria* species but such data may provide confidence for internal nodes.

Relationships of *Thaumastopsaltria smithersi* sp. n.

The fully resolved tree obtained (Fig. 9) shows that *T. smithersi* sp. n. forms a monophyletic group together with *T. adipata* (Stål) (known from just a single specimen from Misoöl Island) + *T. pneumatica* de Boer (known only from Mt Dayman in eastern Papua New Guinea). This group of three is sister to all other *Thaumastopsaltria* species, including the only other Australian species, *T. globosa* (Distant).

Thaumastopsaltria globosa has a wide distribution throughout southern parts of Papua New Guinea, eastern Queensland south to Daintree, and Groote Eylandt on the Northern Territory side of the Gulf of Carpentaria (Fig. 10), a distribution accounted for when sea levels were much lower during several Pliocene-Pleistocene ice ages (between 5-3 and 0.01 Mya), when Queensland was connected to New Guinea via a land bridge and the Gulf of Carpentaria was largely dry (Pigram and Davies 1987, de Boer 1995b). *T. globosa* is not a wet rainforest species and would not have been inhibited in its spread by this specific habitat requirement. In contrast, *T. smithersi* is restricted to wet tropical rainforest between Cooktown and Cardwell (Fig. 10), a habitat that would have shrunk during those past ice ages when conditions were much dryer (Hopkins *et al.* 1993).

It is difficult to explain how *T. smithersi* could have become so isolated from its New Guinean sister species, none of which now inhabit the southern regions of that large island anywhere near Australia. This isolation must have originated a long time ago, possibly as long as 25 Mya when other, now

endemic, Australian Chlorocystini are thought to have entered Australia following the Sepik Arc collision (Daly *et al.* 1991, de Boer 1995b).

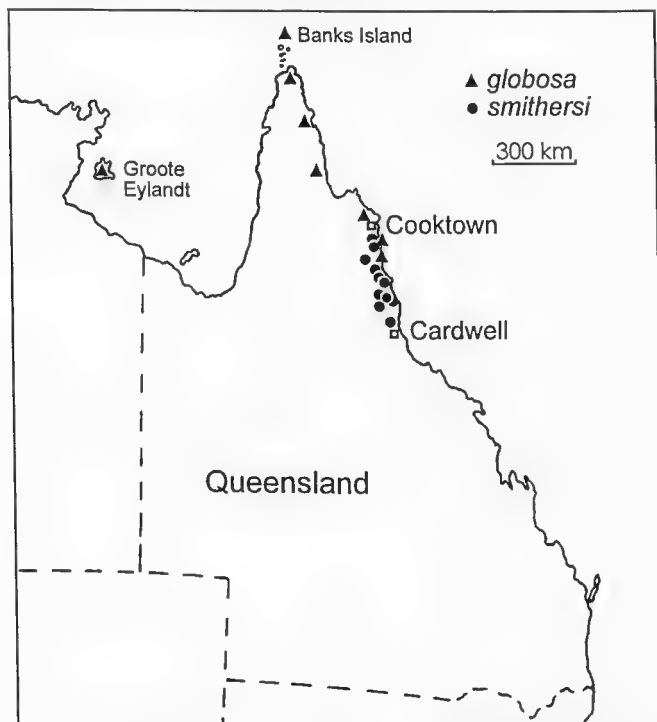


Fig. 10. Distribution of *Thaumastopsaltria smithersi* sp. n. and *T. globosa*.

On the monophyly of *Thaumastopsaltria* Kirkaldy, 1900

De Boer (1992) distinguished *Thaumastopsaltria* on the basis of the shape of the postclypeus and long female ovipositor. The postclypeus in lateral view is obtusely bent at about mid point and thereafter straight to anteclypeus, and the lateral margins show several rows of short parallel ridges. Further, de Boer pointed out that the male pygofer upper lobes in most species are distinctly inflated towards the ventral margin, a feature believed to be unique within *Thaumastopsaltria*.

The monophyly of *Thaumastopsaltria* (incorporating *T. smithersi* sp. n.) is strongly supported in the cladistic analysis by seven non-homoplasious synapomorphies and a bootstrap of 86%. However, three of those synapomorphies have one or more reversals within *Thaumastopsaltria* (characters 24, 65 and 75). The combination of the remaining four synapomorphies (characters 5, 17, 69 and 95) unambiguously define the genus as follows: (a) shape of the postclypeus as mentioned above; (b) paranotum (the lateral side of pronotal collar) rounded; (c) the male pygofer not curved to ventral position; (d) the ventral half of pygofer opening triangular and

pointed rather than broad and rounded. The combination of these four synapomorphies clearly characterises the genus although some of these may have been homoplasious in de Boer's (1995a) large analysis (shared with nodes in other parts of his tree). As de Boer (1992) pointed out, the shape of the postclypeus appears to be the most reliable distinguishing feature. Note that the long female ovipositor, considered by de Boer as a defining attribute for the genus, is not included among the seven synapomorphies identified by the present cladistic analysis (character 152). This is because the ovipositor of *T. smithersi* is short, terminating at about the distal end of abdominal segment 9 and, as *T. smithersi* is near the base of the tree, the analysis treats the character as homoplasious.

Acknowledgements

For helpful comments on the manuscript I am especially grateful to Dr Tony Ewart and Dr Lindsay Popple. A number of people kindly provided specimens for study as detailed in the list of types; to all I extend my sincere thanks. The photographs for Figs 1 and 2 were kindly taken by David Rentz. The line drawings for Figs 3-8 were done by Ivan Nozaic. Financial assistance for the figures was provided by the National Science Foundation, grant number DEB 09-55849.

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A NEW SUBSPECIES OF *DELIAS MYISIS* (FABRICIUS) (LEPIDOPTERA: PIERIDAE) FROM THE GULF OF CARPENTARIA, QUEENSLAND, AUSTRALIA

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Abstract

Delias mysis smithersi subsp. n. is described from Karumba and Kowanyama, southeastern Gulf of Carpentaria, Queensland.

Introduction

Delias mysis (Fabricius) is a common species along the eastern coast of Queensland (subsp. *D. m. mysis*) and less common in the Northern Territory (subsp. *D. m. aestiva* Butler). A new subspecies, collected enroute to the Royal Geographical Society of Queensland Flinders 2002 Expedition to Sweers Island, is from the lower part of the Gulf of Carpentaria, Queensland and is geographically midway between the eastern and western subspecies.

Delias mysis smithersi subsp. n.

(Figs 1-6)

Types. *Holotype* ♂, AUSTRALIA (QUEENSLAND): Karumba, Qld, 17°29'S 140°50'E, 9.x.2003, G. and A. Daniels, urban garden. *Paratypes*: 1 ♂, Karumba, Qld, 17°29'S 140°50'E, 12.xii.2002, G. Daniels, urban; 1 ♂, Mitchell River, Q., 26.x.[19]71. I.S.R. Munro, I.S.R. Munro Collection (all in Australian Museum).

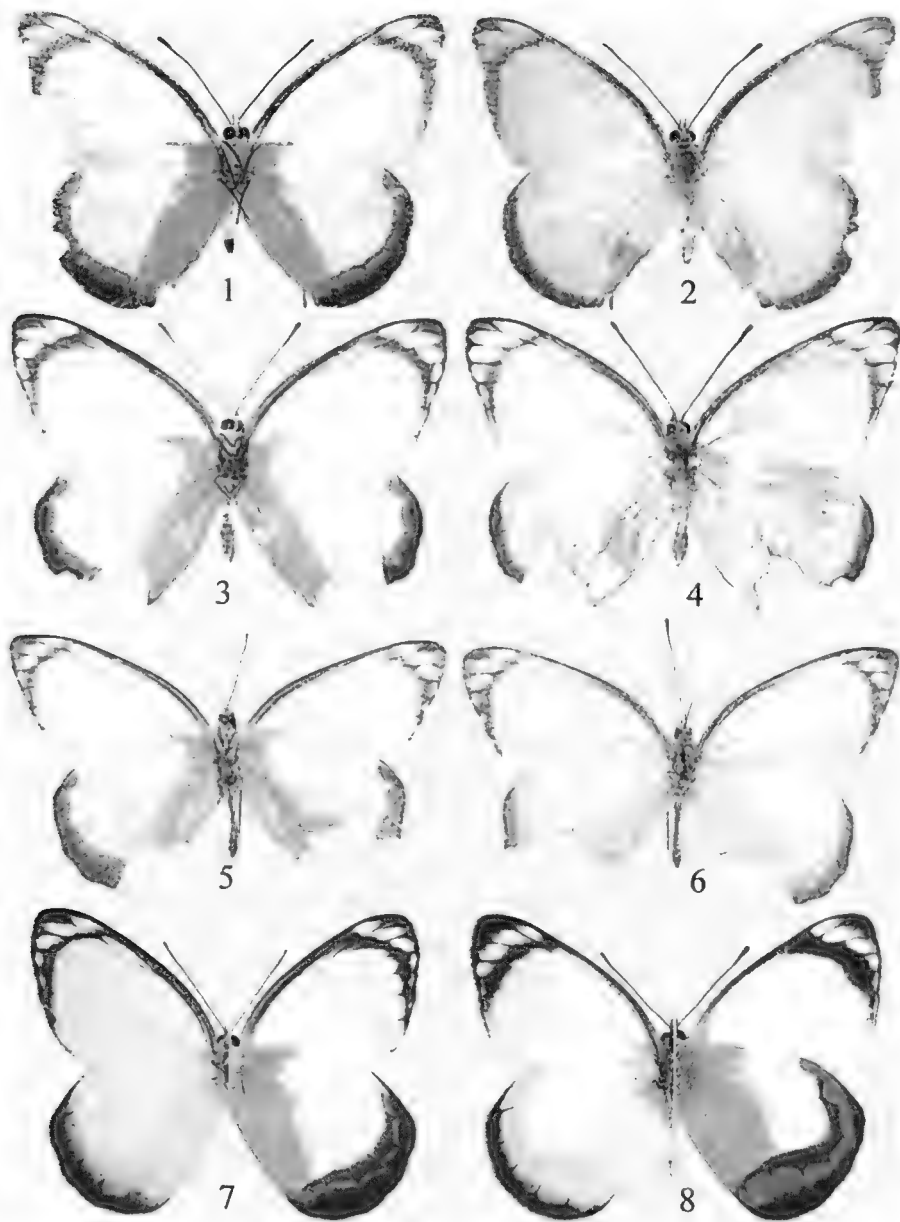
Description. Male. Wingspan 56-60 mm. Upperside. Forewing white, with narrow black costa, apex black enclosing five large white subapical spots. Hind wing white, with narrow black terminal band. The red and black markings on the underside of the hind wing are faintly visible. Underside. Forewing similar to upperside but with the first subapical spot faintly yellow. Hind wing white, with base and dorsum broadly yellow and with a narrow black terminal band bordered by a much narrower scarlet subterminal band which ends at cell Rs; the inner margin of the subterminal band is bordered by an extremely narrow black band which is absent in cell Rs and may be absent in cell M₁.

Female unknown.

Etymology. I am pleased to dedicate this paper to the memory to my late friend, Courtenay Smithers, who gave me much help and encouragement when starting out in entomology many years ago.

Taxonomy

The reduced inner black subterminal band is similar to that of *Delias doylei* Sanford & Bennett from Papua New Guinea but that species has much of the hind wing underside suffused yellow and the subapical spots of the forewing underside are yellow.



Figs 1-8. *Delias mysis* males. (1-6) *D. mysis smithersi* subsp. n. (1-2) Holotype from Karumba: (1) underside; (2) upperside. (3-4) Paratype from Karumba: (3) underside; (4) upperside. (5-6) Paratype from Mitchell River: (5) underside; (6) upperside. (7) *D. mysis aestiva* from Northern Territory. (8) *D. mysis mysis* from Queensland.

Davenport and Mastrigt (2008) reviewed the *Delias mysis* group of species and raised *Delias mysis lara* (Boisduval) from New Guinea to species level, based upon the sympatric distribution of *D. mysis lara* and *D. mysis nemea* Fruhstorfer in the Merauke District of Papua. Davenport and Mastrigt distinguished the two species by the subapical spots on upperside of forewing, being well developed and streak-like, forming a white band with black veins in *D. mysis*, while in *D. lara* they are white, quite poorly developed and even sometimes absent. *Delias mysis smithersi* agrees with the characters given by Davenport and Mastrigt for *Delias mysis*.

The upperside subapical forewing spots of *D. m. smithersi* are larger and the black apical area is less extensive than in *D. mysis mysis* (Fig. 8). The narrow terminal black band of the hind wing upperside is narrower than in *D. mysis mysis*. The hind wing underside has the scarlet subterminal band ending in cell Rs; this feature is shared with *D. mysis aestiva* (Fig. 7).

Delias mysis smithersi differs from *D. mysis aestiva* by the much narrower black terminal band of the hind wing underside and, on the hind wing underside, the black band on the inner margin of the scarlet subterminal band is much wider in *D. m. aestiva* (Fig. 7).

Although some specimens of *D. mysis mysis* have reduced black markings on the upperside, none had a corresponding reduction to the black and scarlet markings on the underside of the hind wing (n = 82) and none had the inner subterminal black band anywhere near as reduced.

The three specimens show little variation. In two specimens the scarlet band in the hind wing cell Rs is present as a spot; one specimen has the apical black area on the upper- and undersides much smaller with a corresponding reduction in the size of the subapical white spots. All specimens are worn, which could indicate a winter flight period.

Distribution

The nearest populations of *Delias mysis* to Karumba and Mitchell River can be found some 500 km to the east, along the eastern coast of Queensland (Braby 2000) and a similar distance to the north-east at Weipa (Hancock and Monteith 2004), where adults are associated with rainforest. Karumba is on the northern edge of the vast savannah-eucalypt woodlands where there are no large tracts of rainforest. Adults of the Northern Territory subspecies, *D. mysis aestiva*, can be found near mangroves and melaleuca swamps (Ted Fenner pers. comm.) and this is perhaps the habitat where the Karumba population is more abundant, as the type locality is situated approximately 500 m from the mangrove areas of the mouth of the Norman River. Collecting there is another matter!

The two Karumba specimens were collected in the grounds of Matilda's End Motel. The first specimen collected was feeding at eucalyptus blossom. Within 200-300 m of the motel grounds are numerous eucalypts festooned

with mistletoe. Despite observing the mistletoe for several days no *Delias mysis* were observed, although *Delias argenthona* (Fabricius) was found to be exceedingly abundant.

Talbot (1937) examined a male specimen from Groote Eylandt (coll. Bodley, ex coll. Joicey) in the northwestern area of the Gulf of Carpentaria. Talbot placed this specimen in subsp. *D. m. mysis*, stating: 'This specimen should belong to *aestiva*; but only differs from *mysis* in having a narrow black outer border on the hind wing beneath.' An examination of the collection of the Natural History Museum, London by R. Eastwood in 2004 failed to locate this specimen and its whereabouts and subspecific placement remain unknown. Apart from this problematic Groote Eylandt record, *D. m. aestiva* is only known to come as far eastwards in the Northern Territory as the Cobourg Peninsula (*vide* Braby 2000).

Acknowledgements

The first specimen from Karumba was collected during the Royal Geographical Society of Queensland Flinders 2002 Expedition to Sweers Island and I thank the Society for its support. Rod Eastwood kindly examined material in the Natural History Museum, London. Max Moulds (Australian Museum), kindly loaned material in his care. Fred Gerrits provided a copy of Davenport and Mastrigt's publication.

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NOTES ON THE BIOLOGY OF *NACADUBA NIUEENSIS* LACHLAN (LEPIDOPTERA: LYCAENIDAE) FROM NIUE, SOUTHWESTERN PACIFIC OCEAN

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Abstract

Additional specimens of *Nacaduba niueensis* Lachlan, 2012 are recorded from the Pacific island of Niue and notes on behaviour of both sexes are recorded for the first time. Fresh females are illustrated and the original description augmented.

Introduction

On a second trip to the Pacific island of Niue between 30 March and 13 April 2012, a further 37 specimens of *Nacaduba niueensis* Lachlan, 2012 were collected. This included 33 males but only 4 females.

Prior to this second survey, *N. niueensis* was known only from two specimens, a male and female described by Lachlan (2012). These two specimens had been collected some 30 years apart.

On this recent trip, from one to six specimens were encountered on each day of the survey. The survey was conducted towards the end of the rainy season and all the days were at least partly sunny.

This paper is dedicated to the memory of a good friend, Courtenay N. Smithers, who took an active interest in the butterflies of Pacific islands.

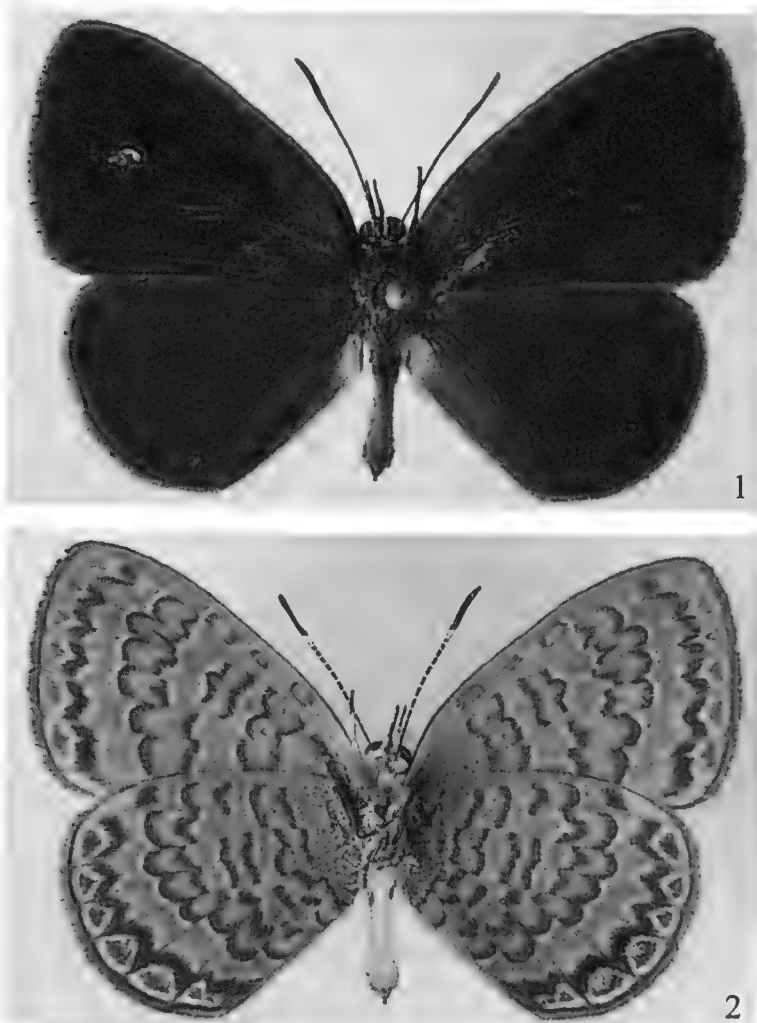
Discussion

Despite careful examination of numerous sites around much of the island, specimens of *N. niueensis* were only ever seen or collected in the far north-west, even though suitable forest habitat is found around much of the island. There were no obvious reasons why this species would be confined to this one area of the island.

During the survey, most males and half the females were collected while alighting on the common forest tree *Alphitonia zizyphoides* (family Rhamnaceae), which was in flower. The males were often observed flying quite rapidly, for short periods, as they arrived at the upper reaches of this tree, then alighting on either the tips of leaves among the clusters of small, white flowers or the flowers themselves, usually facing outwards. They often engaged and drove off other lycaenids; bees and wasps that were attempting to feed on the flowers. They would then fly off over the top of the canopy. Rarely were any other specimens sighted or collected away from this species of tree and none was observed on any other species of tree in the forest or cultivated areas around the island.

Ten males and two females were collected away from this flowering tree in the far north of the island, while flying in, or near, a short section of a partly

enclosed forest trail. Six of these males and the two females were collected inside the shaded forest adjacent to the trail. They were all flying slowly between 1 and 2 metres above the ground.



Figs 1-2. *Nacaduba niueensis*, female: (1) upperside; (2) underside.

The author was lucky to come across two of these flowering trees about 80 metres apart, which allowed relatively easy access to the upper reaches of each tree with a long-handled net. *Alphitonia zizyphoides* trees often reach heights in excess of ten metres, so it is not possible to reach the tops of most of these trees to observe or collect *N. niueensis*, even if they are present.

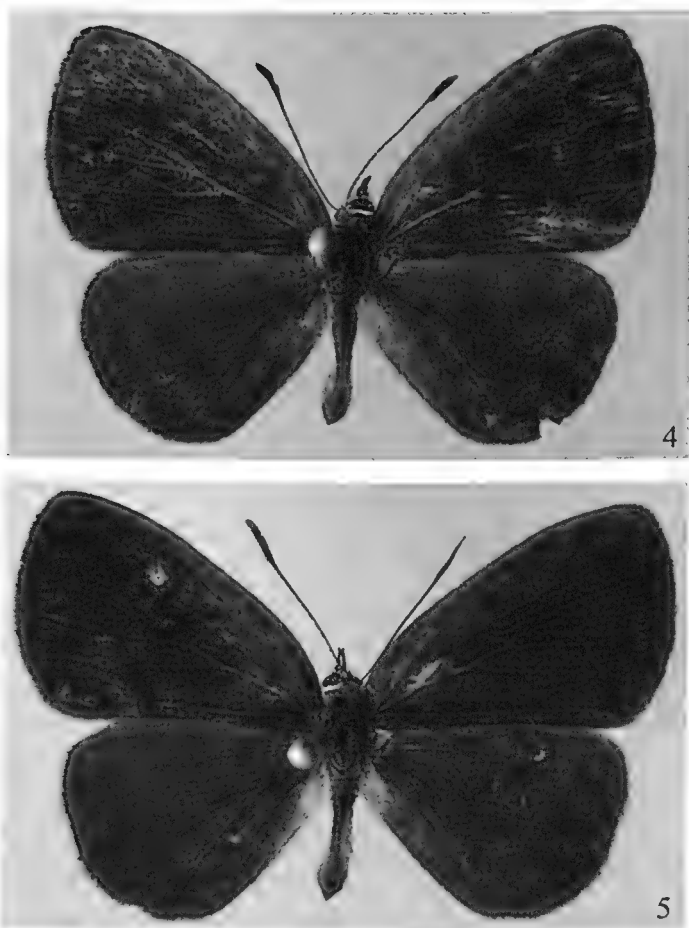
It is now clear that *N. niueensis* primarily inhabits the canopy of the forest on Niue, which largely explains why only two specimens were collected in the previous 30 years and it also appears, at present, to be rather localised in its distribution, for unknown reasons. The vast majority of specimens collected showed varying degrees of wing damage, indicating that they had been flying for some time. There were very few fresh specimens on the wing. This may be indicative of the end of the season for this species. In addition to the specimens collected, close to that number were sighted but not collected, mostly around the two flowering trees mentioned. Therefore, *N. niueensis* appears to be relatively common, at least locally, but very difficult to collect.

Lachlan (2012) described the paratype female from the only specimen known at that time but it was slightly damaged and 32 years old. Additional notes from fresh females are provided below.

Description. Female (Figs 1-5). Upperside, unicolorous very dark brown as in Figs 1, 3-5; on three of the four specimens the basal region of the forewing on either side of the cubitus vein is lightly irrorated with bright, bluish-purple scales to varying degrees; the hind wing is also irrorated with bluish-purple scales but to a lesser degree and only from the basal and subbasal regions. This scaling is more evident when viewed obliquely. In both sexes, on all specimens collected, there is a clearly visible patch of white scaling on the basal third of the inner margin of both hind wings, as in Figs 1, 3-5. This white scaling was not seen as clearly on the holotype or at all on the paratype female. The forewing termen is more rounded than in the male.



Fig. 3. *Nacaduba niueensis*, female upperside showing distinct bluish scaling.



Figs 4-5. *Nacaduba niueensis*, female uppersides: (4) showing a trace of bluish scaling; (5) with no bluish scaling.

Acknowledgements

I am very grateful to Ted Edwards (ANIC, Canberra) and Dr Max Moulds (Research Fellow, Australian Museum, Sydney) for their very helpful comments on the manuscript. I also wish to acknowledge the assistance of Dr David Britton (Collection Manager, Entomology Department, Australian Museum, Sydney) for his production of the digital images of the females. R.G. Coveny (curator of the Rhamnaceae, The Royal Botanic Gardens, Sydney) is also sincerely thanked for identification of the flowering tree.

Reference

LACHLAN, R.B. 2012. A new species of *Nacaduba* Moore (Lepidoptera: Lycaenidae) from Niue, southwestern Pacific Ocean. *Australian Entomologist* 38(2): 49-54.

REVIEW OF AUSTRALIAN *Phyllodes imperialis* DRUCE (LEPIDOPTERA: EREBIDAE) WITH DESCRIPTION OF A NEW SUBSPECIES FROM SUBTROPICAL AUSTRALIA

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Abstract

The subspecies of *Phyllodes imperialis* Druce are reviewed: *P. i. meyricki* Olliff from tropical northeastern Australia and New Guinea is validated and compared with the nominotypical *P. i. imperialis* from the Solomon Islands and *P. i. dealbata* Holloway from New Caledonia. *P. imperialis smithersi* subsp. n., from subtropical southeastern Queensland and northeastern New South Wales, is described and figured.

Introduction

Several genera of large moths previously referred to the subfamily Catocalinae (Noctuidae), including *Phyllodes* Boisduval (1832), were elevated to the family Erebidae (Calpinae: tribe Phyllodini) by Zahiri *et al.* (2011), Holloway (2011) and Zahiri *et al.* (2012). Many species in this group belonging to endemic Australian genera (Common 1990) have remained unplaced (Edwards 1996) since the review of Noctuidae by Kitching (1984). Taxa then included in the family Noctuidae have since been rearranged by Zahiri *et al.* (2011), with Phyllodini now including *Phyllodes*, *Xylophylla* Hampson, *Oporophylla* Hampson, *Lobophyllodes* Hampson, *Minoides* Guenee and *Minophyllodes* Joannis. Of these genera, *Phyllodes* is the only genus occurring in Australia.

Poole (1989) listed 11 species (with synonyms) of *Phyllodes* and regarded *P. imperialis* Druce, 1888, *P. meyricki* Olliff, 1889 and *P. papuana* Hampson, 1913 as separate species. Earlier authors, *e.g.* Olliff (1889) listed 12 species of *Phyllodes*, Seitz (1923) listed 13 and Hampson (1913) provided a key to 11 species. *Phyllodes i. imperialis* was described from the Solomon Islands (Druce 1888) and this subspecies is also known from Bougainville, Papua New Guinea (ANIC unpublished). Several other populations of *P. imperialis* include the distinctive subspecies *P. i. dealbata* Holloway from New Caledonia (Holloway 1979), while other island populations from Vanuatu (Viette 1950), New Britain and New Ireland (Sands unpublished) may also be distinct. *Phyllodes i. meyricki* Olliff, from northern Queensland and New Guinea, is recognised here as a subspecies differing morphologically from *P. i. imperialis* and *P. i. dealbata*. The population previously referred to as a southern subspecies of *P. imperialis* by Sands (1999) is listed both federally (EPBC 2002, Clark and Spier-Ashcroft 2003) and in New South Wales (TSCA 1995) as an endangered subspecies. The habitat for this subspecies, subtropical lowland rainforest, is listed federally as a critically endangered ecosystem (EPBC 2002; endorsed November 2011).

This southern population of *P. imperialis* from eastern Australia is described here as new; it, *P. i. meyricki* and *P. i. imperialis* are illustrated in Figs 1-12.



Figs 1-3. *Phyllodes imperialis*, male uppersides: (1) *P. i. meyricki*; (2) *P. i. smithersi* subsp. n.; (3) *P. i. imperialis*.



4



5



6

Figs 4-6. *Phyllodes imperialis*, male undersides: (4) *P. i. meyricki*; (5) *P. i. smithersi* subsp. n.; (6) *P. i. imperialis*.



7



8



9

Figs 7-9. *Phyllodes imperialis*, female uppersides: (7) *P. i. meyricki*; (8) *P. i. smithersi* subsp. n.; (9) *P. i. imperialis*.



10



11



12

Figs 10-12. *Phyllodes imperialis*, female undersides: (10) *P. i. meyricki*; (11) *P. i. smithersi* subsp. n.; (12) *P. i. imperialis*.

Abbreviations used are: ANIC - Australian National Insect Collection, CSIRO, Canberra; AM - Australian Museum, Sydney; BMNH - Natural History Museum, London; QM - Queensland Museum, Brisbane; Qld - Queensland; NSW - New South Wales; fwl - forewing length; hwl - hind wing length.

***Phyllodes imperialis meyricki* Olliff, 1889, stat. rev.**

(Figs 1, 4, 7, 10)

Phyllodes meyricki Olliff, 1889: 114; Hampson, 1913: 392; Seitz 1923 (Vol. 11): 470.

Phyllodes papuana Hampson, 1913: 392; syn. by Seitz 1923 (Vol. 11): 470.

Phyllodes imperialis Druce; Common 1990: 454; Edwards 1996: 307-308; Zborowski and Edwards 2007: 15.

Types. *Lectotype* ♀ (here designated), AUSTRALIA (QUEENSLAND): labelled 'Mt Bellenden Ker, Cairns, Q.', '*Phyllodes meyricki* Oll.', 'AM registration number K351914'; 1 *Paralectotype* ♀, labelled 'Daintree Riv N. Queensland, Pres. C. French 89.1', '*Phyllodes meyricki* Oll. Type, AM registration number K183621' (both in AM: photographs examined). Olliff (1889) described this taxon from two specimens in the Australian Museum, which he indicated as from 'Mt Bellenden-Ker, near Cairns, and Daintree River, Queensland', but did not designate a Type. A lectotype is designated here in order to stabilise the nomenclature, the specimen selected being the one first mentioned by Olliff (and in better condition).

Other material examined. PAPUA NEW GUINEA: 2 ♂♂, 4 ♀♀, Kiunga, Lae; 1 labelled 'Kiunga 65/516, AUST. NAT. INS. COLL' (NEW GUINEA) (ANIC). AUSTRALIA (QUEENSLAND): northern Queensland: 14 ♂♂, 6 ♀♀ (ANIC), 2 ♂♂, 3 ♀♀ (Sands); male genitalia slides: 1 labelled 'NOCT ♂ 18608 *Phyllodes imperialis* 17°18'S, 145°35'E, Lake Eacham Q, 24 May 1989 IFB Common' (ANIC).

Diagnosis. *Phyllodes i. meyricki* (Figs 1, 4, 7, 10) can be distinguished from *P. i. imperialis* (Figs 3, 6, 9, 12) by its narrower forewings with its margins not so strongly bowed as in the nominotypical subspecies. *P. i. meyricki* is overall larger and the forewings longer (♂♂ fwl: 74-78 mm, n = 5; ♀♀ fwl: 75-85 mm, n = 5) than in *P. i. smithersi* (♂♂ fwl: 58-69 mm, n = 5; ♀♀ fwl: 59-69 mm, n = 6) and the pink hind wing band of *P. i. meyricki*, although variable, is not as wide as in *P. i. imperialis* and extends further towards the apex than in *P. i. smithersi*. *Phyllodes i. meyricki* can be distinguished from *P. i. dealbata* from New Caledonia by the presence of white sub-triangular spots at the vein ends of the hind wing termen, absent in *P. i. dealbata*.

Distribution. The island of New Guinea (Indonesian West Papua and mainland Papua New Guinea) and northern Queensland, Australia (Hunter 1939). In Papua New Guinea recorded from Aroa River (Poole 1989) and Kiunga (ANIC). In Queensland subspecies *P. i. meyricki* is recorded from Mount Bellenden-Ker, Daintree River (Olliff 1889), Atherton, Mutarnee (ANIC), Paluma, Ingham, Tully, Innisfail (L. Ring), Dunk Island, Kuranda, Cooktown, Claudie River and Bamaga (unpublished data and ANIC records).

One specimen from near Proserpine, labelled 'Airlie Beach, N.Q. Sept. 1976, A.W. Smith, CGL Gooding Coll.' (in ANIC) is probably this subspecies but more specimens are required to confirm its status; none of the food plants of *P. imperialis* are known to occur in this region of Queensland.

Larval food plant. The life history and the immature stages of *P. i. meyricki* were described by Hunter (1939). The moth breeds in the heavily-shaded understorey of rainforest, where females oviposit on low, young growth of the vines *Pycnarrhena novoguineensis* Miq. (= *P. australiana*) (Hunter 1939, Fay 1996) and *P. ozantha* Diels (Menispermaceae). Eggs are parasitised by an unidentified *Ooencyrtus* sp. (Hymenoptera: Encyrtidae).

***Phyllodes imperialis smithersi* subsp. n.**

(Figs 2, 5, 8, 11, 13-15, 16-21)

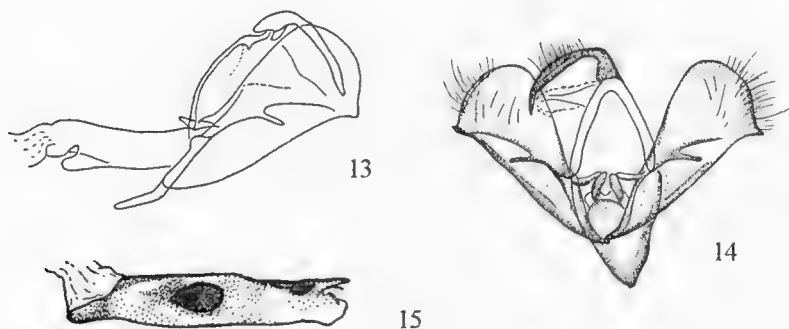
Phyllodes imperialis 'southern subspecies': TSCA 1995; Sands 1999: 386; EPBC 2002 (ANIC Ref. No. 3333), Clark and Spier-Ashcroft 2003: 99; Sands 2012: 38-39.

Types. *Holotype* ♂, AUSTRALIA: labelled 'QUEENSLAND. Mary Cairncross Pk nr Maleny, 26°44'S, 152°52'E, e.p. 27.vi.1988, DPA Sands & R. Broe, larva on *Carronia multisepealea* col. 16.iii.1988' (in ANIC). *Paratypes*: (QUEENSLAND): 4 ♂♂, as above but e.p. 13.v.1988, col. 9.iii.1988; e.p. 24.iii.1988, col. 16.iii.1988; e.p. 6.vi.1988, col. 16.iii.1988, ANIC genitalia slide No. 20391 (all ANIC); 5 ♀♀, as above but e.p. 4.vi.1988, col. 9.iii.1988, e.p. 7.vi.1988, col. 9. iii. 1988, e.p. 6.vi.1988, col. 13.iii.1988, e.p. 14.v.1988, col. 9. iii. 1988 and e.p. 8.vi.1988, col. 5. iv. 1988 (all ANIC); 1 ♂, Mary Cairncross Pk nr Maleny, e.p. 22.i.2004, DPA Sands, larva on *Carronia multisepealea*, col. 22.xii.2003 (QM); 1 ♀, Maleny, 26°44'S, 152°52' E, nr Mary Cairncross Park, to light, 3.xi.2001, A.M. Stabler & A.G. Orr (QM); 1 ♂, labelled '*Phyllodes imperialis* Lamington PN, 16.iii.07 Antoine Levegne leg' (QM); 1 ♀, Upper Currumbin, 4.vi.32, L. Franzen (ANIC). (NEW SOUTH WALES): 1 ♀, Dorrigo National Park, Dorrigo, 18.xi.1990, A.A. Calder (ANIC); 1 ♂, Dorrigo, 27.iii.73, D.S.P 1. ARCH. (ANIC); 1 ♀, ANIC Uni. of New England Coll. donated 1983 (ANIC); 1 ♂, Bellingen Island Reserve, 30°26'55"S, 102°53'47E, egg coll. 13.xi.2006, D. Britton & P Richards, ex pupa 25.i.2007, Australian Museum K243319 (AM); 1 ♂, same except ex pupa 26.i.2007, Australian Museum K243460 (AM).

Description. *Male* (Figs 2, 5). Head, palpus, antenna and thorax light brown; eyes grey-brown, large, rounded, setae obscure; antenna less than half forewing length, slender with short fine setae; palpi upturned, segment 2 very broad, flattened, apically squared, segment 3 short, pencil-like, arising from proximal edge of segment 2; proboscis long, setae very fine, short, without serrations. Forewing length (*holotype*) 66 mm, more than twice width (x 2.1-2.2), ovate (leaf-like appearance), apex produced, costa convex, sub-apically convex; termen obliquely curved, inner margin convex basally; above grey-brown, white area at two thirds length from base at costa, obscure widely-spaced transverse darker bands reaching costa, from sub-apex to base, a dark brown median line from below apex to base of M₃; termen narrowly dark brown, a broad paler terminal band, inwardly broadly toothed, extending

from median line to tornus; subcentral, post-cell reniform near discocellular vein, shape resembling a leaf miner scar, white edged brown and white, broad basally, angled and narrow towards costa. Hind wing longer than wide, apex obtuse, termen convex; above black, costa and base brown, outer margins with 8 triangular subterminal white spots at vein ends, decreasing in size from apex to tornus; a central pink band less than half hind wing width, indented at vein 1A+2A, from M_3 to inner margin above tornus. Beneath grey-brown, forewing with central subtriangular grey-black area, from sub-base to tornus and sub-costa, submarginally-crenate, area with 3 submedian greyish-white areas between tornus and costa. Hind wing veins M_1 to M_3 dark towards termen, with 2 black median transverse and submedian bands M_3 to costa; broad dark grey-brown area to base and inner margin at tornus; overlain by a broad oval postmedian pink band extending about two thirds length of wing, from the tornus to M_3 and reaching Sc, indented at 1A + 2A and Cu A_1 .

Male genitalia (Figs 13-15). Vinculum and tegumen with prominent median junction, saccus subtriangular in dorsal aspect, tegumen apically subtriangular, tapered at base of gnathos; gnathos heavily sclerotized, curved and hook shaped, with apex between apices of valvae clothed in long setae; valvae broadly subtriangular, dorsal edge straight, apex strongly bowed, tapered ventrally to a triangular point, ventral margin weakly convex, ampulla fold with slender, ventrally-directed and pencil-like apically pointed process; juxta hood shaped with short, apical bifurcate sclerotized flanges; aedeagus broadly tubular, base of subzonal sheath rounded, apex truncated, cornuti with median short group of sclerotized cornuti and short apical group near orifice (vesica retracted); prezonal sheath apically broad, with two, rod-like sclerites.



Figs 13-15. *Phyllodes imperialis smithersi*, male genitalia: (13) lateral view; (14) posterior view; (15) aedeagus. (14-15 slide mounted).

Female (Figs 8, 11). Colour similar but often darker than male, wings usually longer and broader than male, forewing costa and inner margin more strongly convex.

Etymology. Named to honour the late Courtenay Smithers.

Variation. The ground colour of both sexes varies from pale grey-brown to dark reddish brown and is usually paler than in ssp. *meyricki*. The reniform mark on the forewing (*sensu* Hampson 1913) is usually white edged dark brown, sometimes brown, or rarely obscure in females.

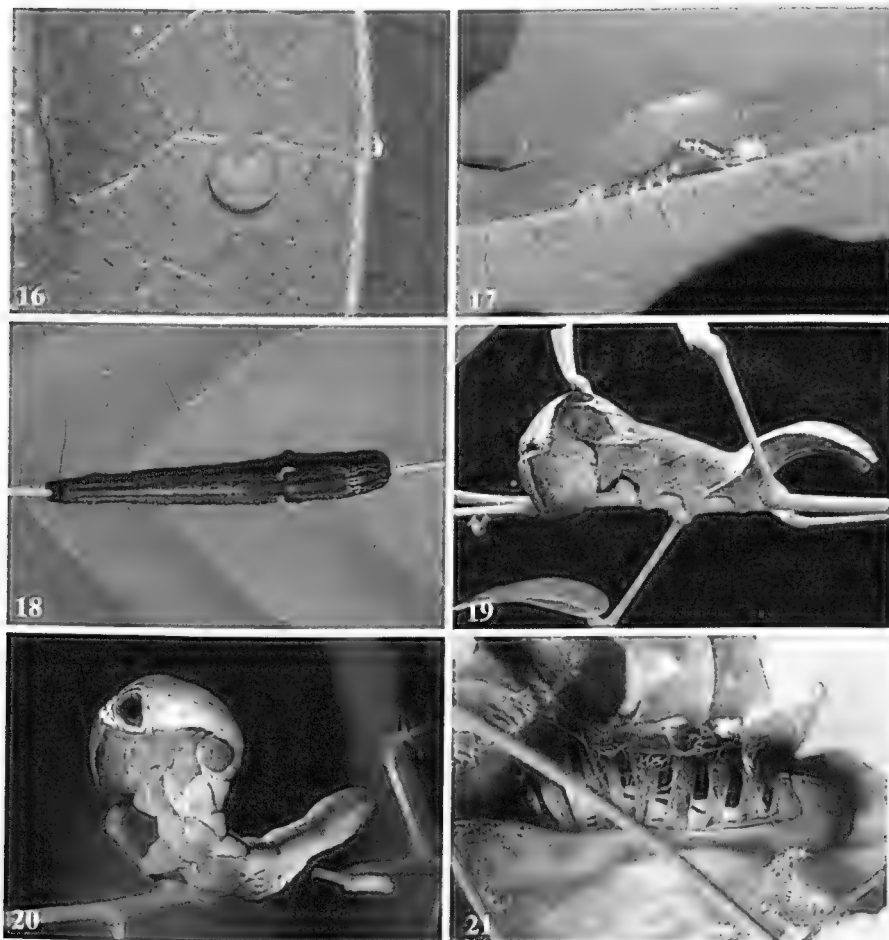
Diagnosis. *P. i. smithersi* is smaller and the forewings ($\sigma\sigma$ fwl: 58-69 mm, $n = 5$, $\omega\omega$ fwl: 59-69 mm, $n = 6$) are significantly shorter than in other subspecies of *P. imperialis*, including *P. i. meyricki* ($\sigma\sigma$ fwl: 74-78 mm, $n = 5$; $\omega\omega$ fwl: 75-85 mm, $n = 5$). The pink hind wing band (measured apex - inner margin) of *P. i. smithersi* (Figs 2, 8) is less than half the width of the hind wing (0.34-0.47:1 hwl) and smaller than in *P. i. meyricki* (0.55-0.62:1 hwl). The termen of the forewings of *P. i. smithersi* (Figs 2, 5, 8, 11) are narrower and the inner margins not as strongly convex as in *P. i. meyricki* (Figs 1, 4, 7, 10). The male genitalia are smaller than in *P. i. meyricki* and *P. i. dealbata* (Holloway) and the apical cornuti (Fig. 15) are less dense and proportionally smaller than in *P. i. meyricki*. Although both subspecies are variable, differences in the colour, shape and forewing length enable *P. i. smithersi* from subtropical eastern Australia to be easily distinguished from *P. i. meyricki* from northern Queensland and mainland Papua New Guinea.

Distribution. Queensland: *P. i. smithersi* occurs at Kin Kin Creek, southeast from Gympie to the NSW-Qld Border Ranges; it has been observed at Conondale (E. Weir pers. comm.), Conondale Range and Witta (R. Thomas pers. comm.), Maleny, Blackall Range (R. Broe, N. Clancy, A. Orr), Bellthorpe, Mount Mee (J. Moss and R. Kendall 2007), Lamington (AM) and Springbrook (R. Bell pers. comm.). New South Wales: *P. i. smithersi* larvae or adults have been photographed or collected at Mount Warning and on the Border Ranges, Richmond Range, Richmond River (unpublished), Billinudgel (K. Vale), Dorrigo (ANIC), Rosewood River (Britton 2006), Bellingen, Huonville (N. Hart) and Bellinger Island (V. Jones, T. Deane pers. comm.).

Larval food plant: *Carronia multisepalea* F. Muell. (Menispermaceae) (Sands 1999, Britton 2006). *C. multisepalea* is an endemic subtropical vine, mostly restricted to 'old growth' subtropical rainforests on the coast and ranges (< ca 1,000 m), from Kin Kin Creek, Qld to the Bellinger River, NSW. The vine frequently occurs in association with another vine, *Pararistolochia praevenosa* (Aristolochiaceae), the principal food plant for the Richmond birdwing butterfly, *Ornithoptera richmondia* (Gray).

Life history. Since discovery of the life history of *P. i. smithersi* and its food plant (Sands 1999), images of the early stages (Figs 16-21) on its food plant

C. multiseppalea, including the remarkable larva, have been published on several occasions (e.g. Moss 2002, Moss and Kendall 2007, Britton 2006, Zborowski and Edwards 2007). Adults have been observed feeding on the damaged fruit of *Ficus* spp. and a *Syzygium* sp.



Figs 16-21. *Phyllodes imperialis smithersi*, immature stages: (16) egg deposited beneath leaf of *Carronia multiseppalea*; (17) first instar larva beneath leaf of *Carronia multiseppalea*; (18) third instar larva; (19) fifth instar larva, resting position; (20) fifth instar larva, alarmed position; (21) pupal case.

Comments

Phyllodes i. imperialis from the Solomon Islands and Bougainville are here considered con-subspecific. Similarly, *P. imperialis* from Lac and Kiunga,

Papua New Guinea and from localities from north of Townsville to the tip of Cape York Peninsula, northern Queensland, are indistinguishable, confirming the synonymy of *P. i. papuana* and *P. i. meyricki* as proposed by Seitz (1923). The subtropical subspecies *P. imperialis smithersi* is confined to notophyll vine forest where the food plant, *C. multisepealea*, is an uncommon endemic vine in eastern Australia, growing on rich volcanic slopes and riparian or alluvial soils. The leaf-like forewings of most *Phyllodes* spp. (Seitz 1923) are similar, with the reniform marking resembling leaf miner scars (M. Horak pers. comm.).

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FERN FLIES OF AUSTRALIA: THE GENUS *TERATOMYZA* S.L. (DIPTERA: TERATOMYZIDAE)

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Australian Museum, 6 College Street, Sydney, NSW 2010

Abstract

The broad concept of the genus *Teratomyza* Malloch (*sensu* McAlpine and de Keyzer 1994) is retained so that *Vitila* McAlpine & de Keyzer, syn. n. and *Poecilovitila* Papp, syn. n. are no longer utilised at either generic or subgeneric level. *Teratomyza* is here provisionally divided into seven informal species groups. *Teratomyza smithersi* sp. n. and *T. pappi* sp. n. (both from Queensland) are described. The following new generic combinations are made for species originally described in *Poecilovitila* Papp: *Teratomyza barbata* (Papp, 2011), comb. n.; *Teratomyza brevicornis* (Papp, 2011), comb. n.; *Teratomyza bulbiscapus* (Papp, 2011), comb. n.; *Teratomyza defecta* (Papp, 2011), comb. n.; *Teratomyza elegans* (Papp, 2011), comb. n.; *Teratomyza erugata* (Papp, 2011), comb. n.; *Teratomyza hindustanica* (Papp, 2011), comb. n.; *Teratomyza japonica* (Papp, 2011), comb. n.; *Teratomyza taiwanica* (Papp, 2011), comb. n.; *Teratomyza thalii* (Papp, 2011), comb. n.; *Teratomyza variegata* (Papp, 2011), comb. n.

Introduction

The Teratomyzidae or fern flies have a mainly south-temperate distribution (South America, Australia, New Zealand), but one of the seven here recognised genera (*Teratomyza* Malloch *s.l.*) has a wider distribution, extending from New Zealand to eastern Asia via Australia and New Guinea. As the Asian species of the family share a set of apomorphic character states with certain of the temperate Australasian taxa, I consider that all these should be included in the apparently monophyletic, though polytypic, genus *Teratomyza*, as delimited by McAlpine and de Keyzer (1994).

This paper makes known two undescribed species of *Teratomyza* of Queensland. Some additional undescribed species of New Guinea and the Oriental Region are mentioned below under *Teratomyza* groups 2-6.

The following abbreviations are used for institutions holding collections: AM, Australian Museum, Sydney; ANIC, Australian National Insect Collection, CSIRO, Canberra; BPB, B.P. Bishop Museum, Honolulu; CNC, Canadian National Collection, Agriculture Canada, Ottawa; HELS, Zoological Museum, University of Helsinki, Helsinki; QM, Queensland Museum, Brisbane.

Notes on morphology

The nomenclature of the bristles (enlarged and individually differentiated macrotrichia) on the upper back of the head in schizophoran flies has been confused in the literature. I have attempted (McAlpine 2007) more accurately to systematise the identification and terminology of these bristles, and this system is here relevant because of taxonomic variation in the bristle pattern in *Teratomyza s.l.* The postvertical bristles are reduced in the Teratomyzidae and are often scarcely differentiated from the nearby setulae (small macrotrichia of irregular placement). In *Teratomyza* group 1 (including *T.*

neozelandica Malloch and perhaps one or two closely similar species), the series of postocular setulae terminates dorsomedially below the level of the outer vertical bristle. Widely separated from that series and located behind and slightly mesad of the inner vertical bristle (Fig. 2), is the bristle I identify as the paravertical bristle, as it corresponds in position to that bristle in other families (e.g. *Heteromyzidae* and *Pseudopomyzidae*). In other species groups (e.g. group 7, Fig. 3), there is no such isolated paravertical bristle and the series of postocular setulae often extends further mesad.

In some teratomyzid taxa (numerous examples figured by McAlpine and de Keyser 1994 and Papp 2011), some of the macrotrichia on the surstylus of the male are short, very stout, and peg-like or tooth-like (see Figs 5, 6, 8). I refer to these as blunt spinules, to distinguish them from the slender, fine-tipped setulae, often also present on the surstylus.

Genus *Teratomyza* Malloch

Teratomyza Malloch, 1933: 113-114. Type species *T. neozelandica* Malloch (original designation).

Vitila McAlpine & de Keyser, 1994: 321 (as subgenus of *Teratomyza*). Type species *T. (Vitila) undulata* McAlpine & de Keyser (original designation). Syn. n.

Poecilovitila Papp, 2011: 11. Type species *P. elegans* Papp (original designation). Syn. n.

Diagnostic description. Head. Postfrons not setulose anteriorly; cheek region commonly with upper and lower series of setulae; palpus absent or very minute. Thorax. Dorsocentral bristles two pairs; mesopleural (anepisternal) and pteropleural (anepimeral) bristles absent; costa distally with variably reduced setiferous tubercles; anal cell (cup) not strongly enclosed on posterior side; alular lobe and alular incision absent; fringe of alular setulae reduced or absent. Male postabdomen. Aedeagus prominent, somewhat elongate, asymmetrical. Female abdomen. Tergite 7 and sternite 7 broadly fused, annular.

Notes. The genus *Teratomyza* *sensu* McAlpine and de Keyser (1994) has been divided into three genera by Papp (2011), viz. *Teratomyza* (*s.str.*), *Vitila* and *Poecilovitila*. My own studies indicate that these categories are less well defined than indicated by Papp and that his restricted genus *Teratomyza*, still including both Asian and New Zealand species and defined only by plesiomorphic character states, is very probably paraphyletic. I find significant morphological differences between the available Asian and New Zealand taxa (the latter including the type species), but both categories lack the obvious apomorphic wing features that characterise his so-called genera *Vitila* and *Poecilovitila*. Several taxa not considered by Papp possess character combinations which tend to link his major groupings, but some are still very incompletely known. I consider that the apparently monophyletic genus *Teratomyza* *s.l.* (e.g. Fig. 1) is best divided into seven informal species

groups on the basis of present knowledge, and that such formal categories as subgenera should be avoided.



Fig. 1. *Teratomyza smithersi* sp. n., male from Upper Tully River.

Key to species groups of *Teratomyza* s.l.

- 1 Paraverticlar bristle usually present behind and slightly mesad of inner vertical bristle and widely separated from largest postocular setula, latter located behind but not mesad of outer vertical bristle (Fig. 2); male: surstylus arising well within border of epandrium; cercus vestigial or apparently absent; New Zealand group 1

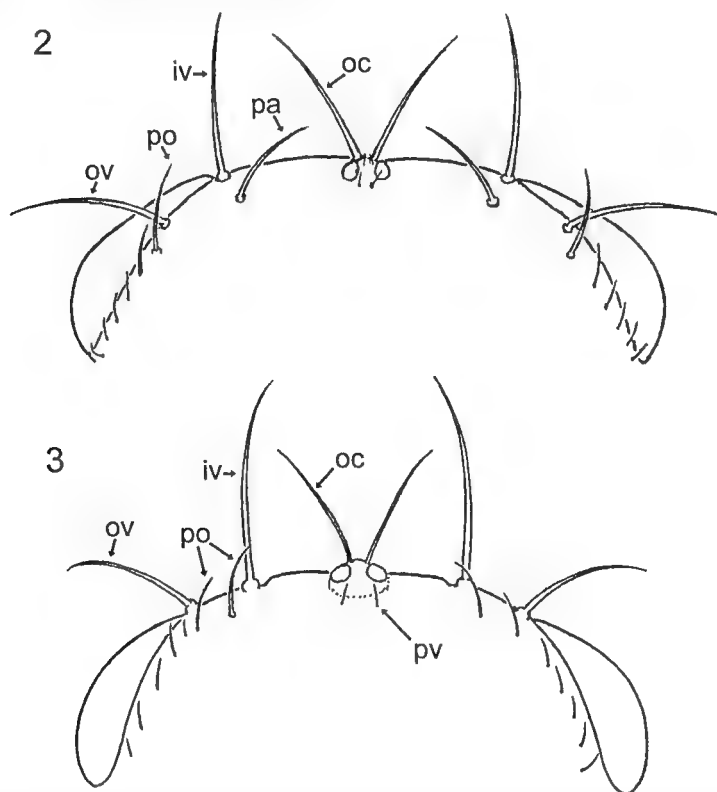
- Paraverticlar bristle absent; largest postocular setula located at least slightly laterad of inner vertical bristle and not widely separated from rest of postocular series (Fig. 3); male (where known): surstylus articulated with lateral margin of epandrium; cercus well developed, setulose; not in New Zealand 2
- 2 Postfrons with longitudinal stripes; wing membrane with four or five white spots between costa and vein 2; sternopleural bristles two, large; eastern Australia group 7
- Postfrons without longitudinal stripes; wing without series of white spots between costa and vein 2; only one sternopleural bristle well developed; not in Australia 3
- 3 Vein 2 near its mid-length closely approximated to costa, but usually diverging from costa again before distal termination 4
- Vein 2 not closely approximated to costa and then diverging before distal termination 6
- 4 Anterior crossvein (r-m) at least twice as long as discal crossvein (dm-cu); basal section of vein 4 strongly arched, making second basal cell much broader than first basal cell in this region; New Guinea group 6
- Anterior crossvein not much longer than discal crossvein; basal section of vein 4 not arched, thus second basal cell not broader than first basal cell; Oriental and eastern Palaearctic Regions 5
- 5 Wing membrane with some brownish shading and usually a hyaline spot in submarginal cell beyond end of vein 2; vein 5 with complex curvature (sometimes slight) immediately beyond discal crossvein (Papp 2011: figs 112-121); transverse ridge of vertex strongly elevated laterally so that, in exact profile, outer vertical bristle arises much above upper margin of eye group 5
- Wing membrane quite clear; vein 5 without such complex curvature; transverse ridge of vertex relatively little elevated laterally, outer vertical bristle arising little above upper margin of eye group 4
- 6 Ocellar bristle small, not over half as long as fronto-orbital bristle; eye markedly longer than high; vein 2 rather strongly curved; thoracic pleura with dark brown longitudinal stripe; New Guinea group 3
- Probably not agreeing in above characters (only limited material and limited published information available); Oriental and eastern Palaearctic Regions group 2

Teratomyza group 1

Included species: *Teratomyza neozelandica* Malloch; possibly one or more closely related undescribed species.

Distribution: New Zealand (North and South Islands).

Notes. This group is not adequately studied, but my observations suggest that it can be distinguished from other groups by the characters given in the key. Of the 29 specimens examined, only one lacks the paravericals shown in Fig. 2. The surstylus lacks blunt spinules.



Figs 2-3. Vertex of head, posterior view of: (2) *Teratomyza* nr *neozelandica* (group 1); (3) *Teratomyza smithersi* sp. n. (group 7). iv = inner vertical bristle, oc = ocellar bristle, ov = outer vertical bristle, pa = paraverticlar bristle, po = postocular setulae, pv = postvertical bristle.

Teratomyza group 2

Included species: *Teratomyza chinica* Yang Chikun; *T. formosana* Papp; *T. sp. undescr.* (Nepal, CNC).

Distribution: Oriental Region—Vietnam, Taiwan, China, Nepal.

Notes. Representatives of this group have principally been made known by Papp (2011), who described and figured the male postabdominal structure for

two species. The one species available to me (Nepal, CNC) has the mesoscutum anteriorly simply convex, no dark pleural stripe on the thorax, the postfrons very densely pruinose, all in contrast to the condition in group 3. This species has few large terminal blunt spinules on the slender surstylus, in contrast to the two species treated by Papp.

***Teratomyza* group 3**

Included species: *Teratomyza* sp. undescr. (Myola, Oro Province, AM).

Distribution: New Guinea (only yet known from Owen Stanley Range, Oro Province, Papua New Guinea).

Notes. The specimens (two females) show the distinctive characters given in the key to groups, but, until males become known, an adequate review of relationships is not possible. The two female specimens, collected at the same locality by J.W. Ismay, show slight differences in wing venation and chaetotaxy, and there is a slight possibility that they are not conspecific. In any case, the species cannot be accurately characterised without knowledge of the male postabdomen.

***Teratomyza* group 4**

Included species: *Teratomyza* sp. undescr. (Nepal, CNC).

Distribution: Oriental Region—Nepal.

Notes. The group is known to me from one male specimen. It resembles some species of group 5 (*Poecilovitila*) in having vein 2 on a substantial part of its length thickened and closely approximated to the costa. Otherwise it is without the apomorphic wing conditions of that group and superficially resembles examples of groups 1 and 2.

***Teratomyza* group 5**

Included species: *Teratomyza barbata* (Papp, 2011) comb. n.; *Teratomyza brevicornis* (Papp, 2011) comb. n.; *Teratomyza bulbiscapus* (Papp, 2011) comb. n.; *Teratomyza defecta* (Papp, 2011) comb. n.; *Teratomyza elegans* (Papp, 2011) comb. n.; *Teratomyza erugata* (Papp, 2011) comb. n.; *Teratomyza hindustanica* (Papp, 2011) comb. n.; *Teratomyza japonica* (Papp, 2011) comb. n.; *Teratomyza taiwanica* (Papp, 2011) comb. n.; *Teratomyza thalii* (Papp, 2011) comb. n.; *Teratomyza variegata* (Papp, 2011) comb. n.; *Teratomyza* sp. undescr. (NE Burma, HELS); *Teratomyza* sp. undescr. (Fukien Province, S. China, BPB); *Teratomyza* sp. undescr. (Luzon, Philippines, BPB); *Teratomyza* sp. undescr. (Sabah (North Borneo), Malaysia, CNC). A few other specimens could represent additional Oriental species.

Distribution: Oriental Region and adjacent parts of Palaearctic Region—Japan, China, Taiwan, Nepal, India, Philippines, Vietnam, Burma, Thailand, Malaysia.

Notes. Group 5 is apparently the largest group in the genus, with at least 15 species, but none is known from east of Wallace's Line. It appears from Papp's study that all species probably have a well developed series of blunt spinules on the distal margin of the surstylus, a feature that is shared with group 7.

This group includes the type species of *Poecilovitila* Papp.

***Teratomyza* group 6**

Included species: *Teratomyza* sp. undescr. (Papua New Guinea: mainland).

Distribution: New Guinea.

Notes. The one included species resembles those of groups 4, 5, and 7 in having vein 2 undulate, thickened, and closely approximated to the costa well before its distal end, but differs from these in its own specialised wing features as indicated in the key. A much reduced series of blunt spinules is present on the surstylus. None of these three other groups is known from New Guinea, but the smaller flies of that island are still very incompletely known.

***Teratomyza* group 7**

Included species: *Teratomyza undulata* McAlpine & de Keyzer; *Teratomyza smithersi* sp. n.; *Teratomyza pappi* sp. n.

Distribution: eastern Australia, including Tasmania.

Notes. Group 7 is easily distinguished by the presence of two or three undulations in vein 2, presence of many white spots on the wing membrane including four or five between the costa and vein 2, and the presence of two large sternopleural bristles.

This group includes the type species of subgenus *Vitila* McAlpine & de Keyzer, *Teratomyza undulata* McAlpine & de Keyzer.

Key to species of *Teratomyza* group 7

- 1 Anterior and discal crossveins separated by not more than length of discal crossvein, or these two crossveins contiguous; first posterior cell (behind distal section of vein 3) with more than eight white spots; area behind vein 6 with two white spots; male: surstylus as in Fig. 6 *undulata* McAlpine & de Keyzer
- Anterior and discal crossveins separated by at least twice length of discal crossvein; first posterior cell with fewer than eight white spots; only one white spot behind vein 6; male: surstylus differently shaped 2
- 2 Vein 2 usually with three marked undulations (Fig. 4); usually five large white spots present between costa and vein 2; submarginal cell (behind distal section of vein 2) usually with seven to nine white spots; male: surstylus narrowed beyond base, so that spinulose distal margin is not

- more than half as long as basal margin (Fig. 5); cercus more than half as long as surstylus *smithersi* sp. n.
- Vein 2 with two marked undulations and sometimes an indistinct one distally (Fig. 7); usually four white spots present between costa and vein 2, or sometimes a smaller additional spot distally; submarginal cell usually with six white spots; male: surstylus somewhat narrowed towards mid-length, but expanded again distally, so that spinulose distal margin is as long as basal margin (Fig. 8); cercus not more than half as long as surstylus *pappi* sp. n.

Teratomyza undulata McAlpine & de Keyzer

(Fig. 6)

Teratomyza (Vitila) undulata McAlpine & de Keyzer, 1994: 321-324, figs 36-43.

Vitila undulata (McAlpine & de Keyzer),—Papp 2011: 10.

Description. See McAlpine and de Keyzer (1994).

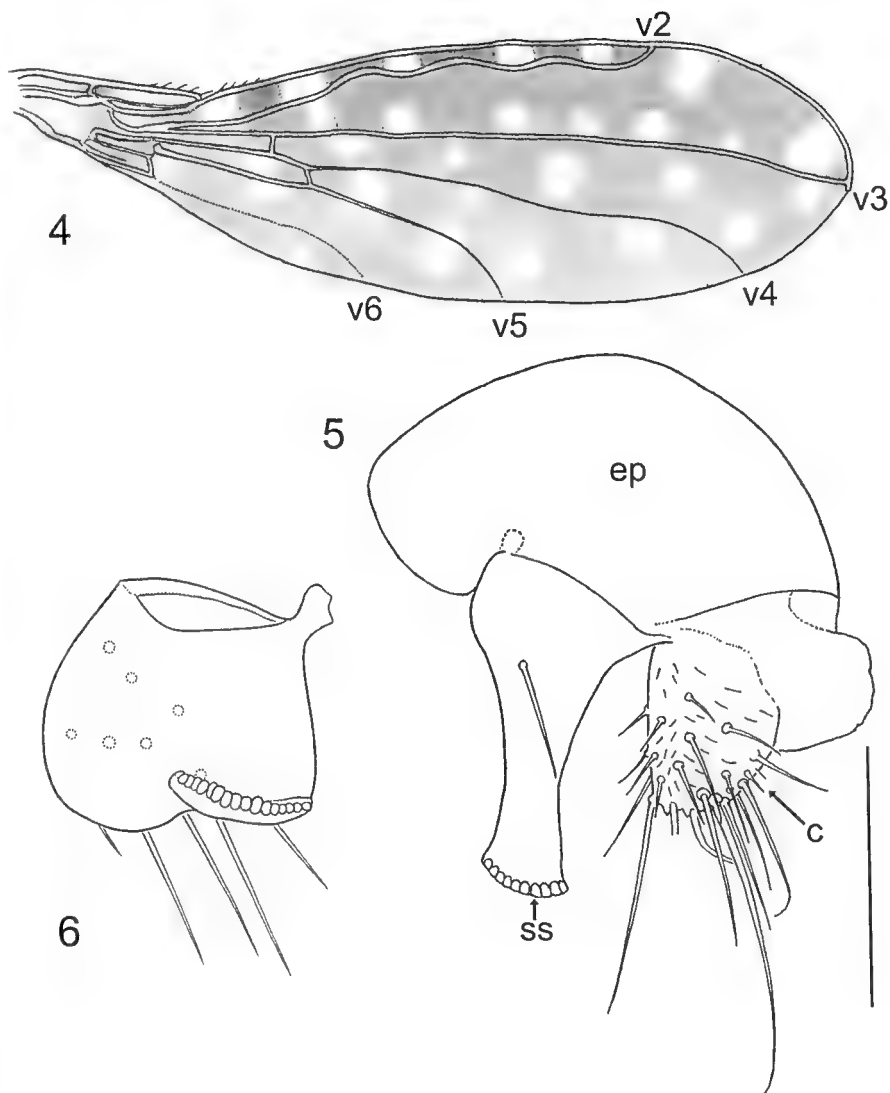
Distribution. Mainly higher rainfall areas from Eungella (Dalrymple Heights) district, Queensland, to eastern Victoria and western Tasmania. See McAlpine and de Keyzer for details.

Teratomyza smithersi sp. n.

(Figs 1, 3-5)

Types. *Holotype* ♂, QUEENSLAND: Crawford's Lookout, Palmerston Highway, 17.61°S 145.79°E, 8.viii.2010, S.F. McEvey, J. Weiner (AM, K300569, S.McE 28392). *Paratypes.* QUEENSLAND: 2 ♂, 1 ♀, Crawford's Lookout, Palmerston Highway (AM); 1 ♂, Mossman Gorge, April 1967, D.H. Colless (ANIC); 1 ♀, 5-8 km on Mount Lewis Road off Mossman-Mount Molloy Road, April 1967, D.H. Colless (ANIC); 2 ♀, 3 km NNE of Julatten, Sept. 1980, D.H. Colless (ANIC); 1 ♀, Kuranda Range State Forest, Black Mountain Road, April 1967, D.H. Colless (ANIC); 1 ♀, Kuranda, May 1958, D.K. McAlpine (AM); 1 ♂, Barron Falls, near Kuranda, May 1958, D.K. McAlpine (AM); 4 ♂, 2 ♀, Mount Edith, 4-7 miles (c. 6-11 km) off Danbulla Road, April 1967, D.H. Colless (ANIC); 6 ♂, 4 ♀, Mount Edith Forest road, 1-1.5 miles off Danbulla Road, May 1967, D.H. Colless (ANIC); 1 ♀, Wongabel State Forest, near Atherton, May 1967, D.H. Colless (ANIC); 2 ♂, 3 ♀, The Boulders, near Babinda, May 1967, July 1971, D.H. Colless, Z.R. Liepa (ANIC); 15 ♂, 18 ♀, The Crater [Ringrose National Park or Mount Hypipamee], Jan, May, Dec. 1961-1972, D.H. Colless, G.A. Holloway, D.K. McAlpine (AM, ANIC, QM); 1 ♀, Palmerston National Park, 23 km NE of Ravenshoe, Nov. 1981, D.H. Colless (ANIC); 1 ♂, summit, Walter Hill Range, Cardstone-Ravenshoe Road, Jan. 1967, D.K. McAlpine, G.A. Holloway (AM); 1 ♂, upper Tully River valley, 17.77°S 145.65°E, Aug. 2010, S.F. McEvey (AM); 1 ♂, Kirrama rain forest [Kirrama Range vicinity between Tully and Herbert Rivers], Aug. 1976, I.R. Bock, P.A. Parsons (ANIC).

Other material. QUEENSLAND: Paluma vicinity, including Birthday Creek (AM, ANIC).



Figs 4-6. *Teratomyza* spp.: (4) *T. smithersi* sp. n., wing; (5) *T. smithersi*, left lateral view of epandrium and associated structures, setulae on epandrium omitted; (6) *T. undulata*, right surstylus, medial view. Scale for Fig. 5 = 0.1 mm. c = cercus, ep = epandrium, ss = surstylus, v2-v6 = veins 2-6.

Description (male, female). A small slender fly, generally resembling the well known *T. undulata* (see McAlpine and de Keyzer 1994 for detail).

Coloration. Head pale tawny-yellow to creamy; postfrons with three broad dark brown to blackish longitudinal stripes on its full length, with whitish

intermediate zones and lateral margins; face, cheeks, and occiput without darker markings. Antenna grey-brown. Thorax pale tawny, with paler mostly creamy pleura, often slightly darker towards upper margin or with distinct brown upper marginal stripe; scutellum usually yellow at extreme apex. Wing membrane grey-brown, darker anteriorly, with numerous white spots, fewer than in *T. undulata*; marginal cell with five large white spots between costa and vein 2, and a smaller pale zone in extreme base; submarginal cell usually with eight or nine white spots. Halter tawny-yellow to grey-brown. Legs yellowish; femora sometimes slightly darker apically. Abdominal tergites tawny-brown, in male usually without markings except for yellow lateral zones on tergite 6, in female often with yellow lateral zones on most tergites.

Head and thorax structurally similar to those of *T. undulata*. Wing: vein 2 with three distinct undulations on which it is thickened and approximated to costa; vein 6 with single undulation or region of curvature; anterior and discal crossveins separated by at least twice length of discal crossvein.

Male postabdomen. Surstylus rather broad basally, much narrowed beyond base, so that spinulose distal margin is much shorter than basal margin articulating with hypandrium; pregonite broadly ovate, larger than surstylus; cercus rather large and stout, with long and short setulae.

Dimensions. Total length, ♂ 1.7-1.9 mm, ♀ 1.9-2.2 mm; length of thorax, ♂ 0.74-0.78 mm, ♀ 0.93-1.00 mm; length of wing, ♂ 2.2-2.4 mm, ♀ 2.8-2.9 mm.

Etymology. The name refers to my late friend Courtenay N. Smithers, formerly of the Australian Museum.

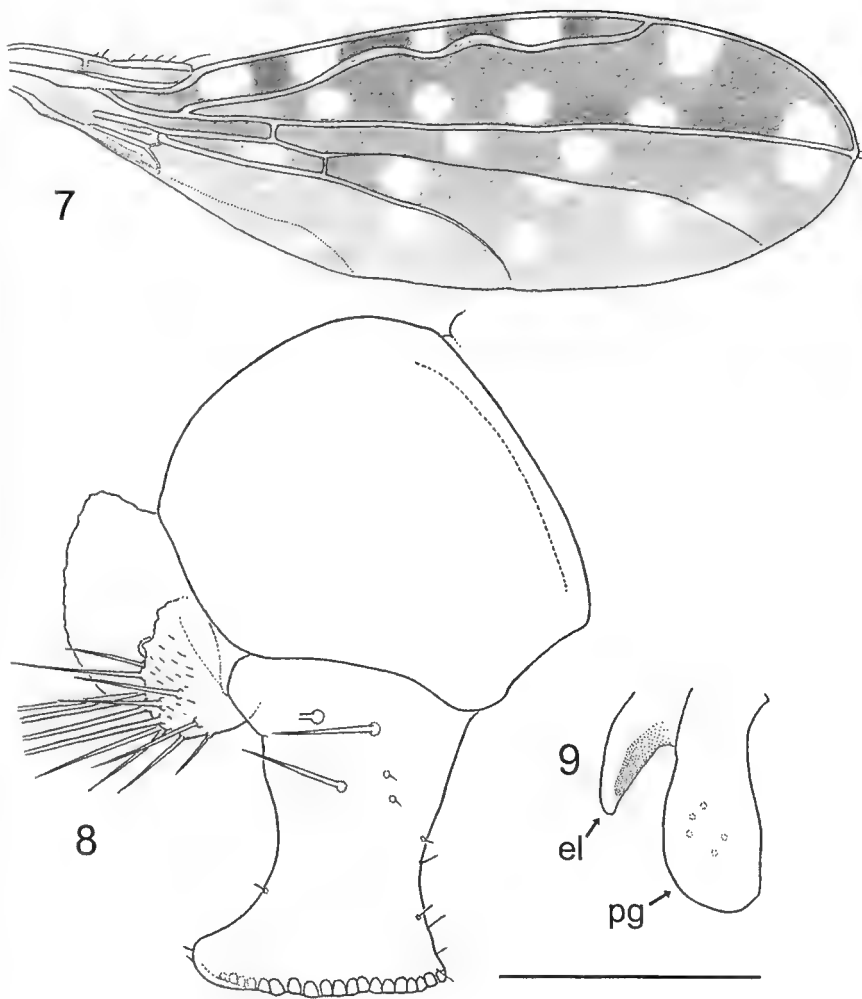
Distribution. Tropical coast of Queensland between 16°S and 19°30'S. It is thus apparently geographically isolated from populations of *T. undulata* but sympatric with *T. pappi*.

Notes. *Teratomyza smithersi* resembles *T. undulata* but differs in characters of wing venation, as indicated in the above key, and in the shape of the surstylus and pregonite. For comparison with *T. pappi* see under that species.

Teratomyza pappi sp. n.

(Figs 7-9)

Types. Holotype ♂, QUEENSLAND: Ringrose National Park [The Crater or Mount Hypipamee], 5.v.1967, D.H. Colless (ANIC). *Paratypes.* QUEENSLAND: 1 ♂, same data as holotype (AM); 1 ♂, 5-8 km up Mount Lewis Road, from Mossman-Mount Molloy Road, April 1967, D.H. Colless (ANIC); 3 ♂, Mount Edith, 4-7 km off Danbulla Road, Atherton district, April 1967, D.H. Colless (ANIC).



Figs 7-9. *Teratomyza pappi* sp. n.: (7) wing; (8) right lateral view of epandrium and associated structures, setulae on epandrium omitted; (9) right pregonite and epiphallus. Scale for Figs 8 and 9 = 0.1 mm. el = epiphallus, pg = pregonite.

Description (male only known). A small fly closely resembling *T. undulata* and *T. smithersi*, agreeing with description of the latter, except as indicated below.

Coloration. Head and thorax as in *T. smithersi*; thoracic pleura with definite brown upper marginal stripe. Wing pattern resembling that of *T. smithersi*; usually only four white spots between costa and vein 2 (one specimen showing a smaller distal additional white spot); submarginal cell with six

white spots; only one pale spot between vein 6 and wing margin. Halter with dark grey capitellum (mature specimens).

Head and thorax structurally similar to those of *T. undulata* and *T. smithersi*. Wing: vein 2 with two marked undulations, thickened along their summits, and at most a trace of more distal undulation.

Male postabdomen. Surstylus narrowed towards mid-length, but expanded distally so that distal margin is as long as basal articulating margin and posterodistal angle is subacute; pregonite much shorter than surstylus, slightly narrowed basally, broadly rounded distally; cercus much smaller than in *T. smithersi*.

Dimensions. Total length, 1.8-1.9 mm; length of thorax, 0.75-0.80 mm; length of wing, 2.2-2.3 mm.

Etymology. The name refers to László Papp, who has made the major contribution to knowledge of Oriental Teratomyzidae.

Distribution. Northern Queensland—Atherton to Mossman districts. The distribution is included within that of *T. smithersi*.

Notes. *Teratomyza pappi* is very similar to *T. smithersi* but is distinguished by the contour of vein 2, the distribution of pale wing spots and, in the male, by details of the surstylus, pregonite and cercus.

Acknowledgements

Donald Colless, John Ismay, Shane McEvey, Richard Vockeroth and Jean Weiner supplied significant material. Helen Smith reviewed the manuscript and aided in its preparation. Scott Ginn provided the colour photograph.

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SYSTEMATIC AND DISTRIBUTIONAL NOTES ON SOME AUSTRALASIAN AND AFRICAN SPECIES OF *PLATENSINA* ENDERLEIN AND *DICHENIOTES* MUNRO (DIPTERA: TEPHRITIDAE: TEPHRITINAE), WITH DESCRIPTION OF A NEW SPECIES OF *DICHENIOTES* FROM KENYA

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Abstract

The tephritine genera *Platensina* Enderlein and *Dicheniotes* Munro are discussed, with several new distribution records and keys to all known species provided. The Australian *Platensina trimaculata* Hardy & Drew and SE Asian *P. quadrula* Hardy are returned to *Platensina*; the East Asian *P. assimilis* (Shiraki), comb. n. and *P. shirouzui* (Ito), comb. n. are transferred from *Bezzina* Munro; *P. voneda* (Walker) is placed as a new synonym of *P. acrostacta* (Wiedemann) and its type locality presumed to be Bengal, India; *P. fukienica* Hering is placed as a new synonym of *P. tetrica* Hering; *P. platyptera* Hendel, stat. rev. (= *P. malaita* Curran, syn. n.; = *P. dubia* Malloch, syn. n.) and *P. dilatata* Hering are removed from synonymy with *P. amplipennis* (Walker), with *P. dilatata* placed as a new synonym of *P. ampla* de Meijere; a record of '*Pliomelaena* sp. B' from Papua New Guinea and all records of *P. amplipennis* from the Australian Region are referred to *P. platyptera*. The primarily Afrotropical *Dicheniotes aeneus* (Munro), *D. alexina* (Munro), *D. asmarensis* (Munro), *D. enzoria* (Munro), *D. parviguttatus* (Hering), *D. sokotrensis* (Hering) and *D. ternarius* (Loew) are transferred as new combinations from *Pediapelta* Munro. *Dicheniotes kakamegae* sp. n. is described from western Kenya.

Introduction

Hancock (2001) placed the tephritine genus *Bezzina* Munro in the *Platensina* group of genera, within the tribe Dithrycini, subtribe Platensinina (= Oedaspina), a distinctive assemblage of flies known to form stem galls on various species of Asteraceae, Goodeniaceae and Onagraceae. However, a molecular investigation by Han *et al.* (2010 and pers. comm.) has indicated that the type species of *Bezzina*, the Afrotropical *B. margaritifera* (Bezzi), appears to be much more closely related to *Chippingomyia manica* Hancock (provisionally referred to the *Campiglossa* group in tribe Tephritini by Hancock 2006) than to platensinines such as *Oedaspis* Loew and *Platensina* Enderlein. Accordingly, the four non-African species assigned to *Bezzina* by Hancock (2001) are currently misplaced. This error is corrected below and notes on several other *Platensina* species are included, including the removal of all current synonyms of *P. amplipennis* (Walker) to other species.

Hancock (2010) noted that all except the type species currently included in the African genus *Pediapelta* Munro (with one record from SE Queensland), in tribe Tephrellini, appeared to be better placed in *Dicheniotes* Munro, a possibility initially suggested by Munro (1947) when describing *Pediapelta*. Examination of most of the included species has supported this suggestion.

Abbreviations: AQIS - Australian Quarantine and Inspection Service, Cairns; BMNH - Natural History Museum, London; OUMNH - Oxford University Museum of Natural History, Oxford.

This paper is dedicated to the memory of Courtenay N. Smithers who, like the present writer, experienced the pleasures of working in both Africa and Australia. We both worked, at different times, on tsetse flies and plant pests for the then Rhodesian Departments of Veterinary Services (Tsetse & Trypanosomiasis Control Branch) and Research and Specialist Services (Plant Protection Research Institute) before becoming Museum curators.

Systematic and distributional notes

Tribe Dithrycini (subtribe Platensinina)

Platensina Enderlein, 1911

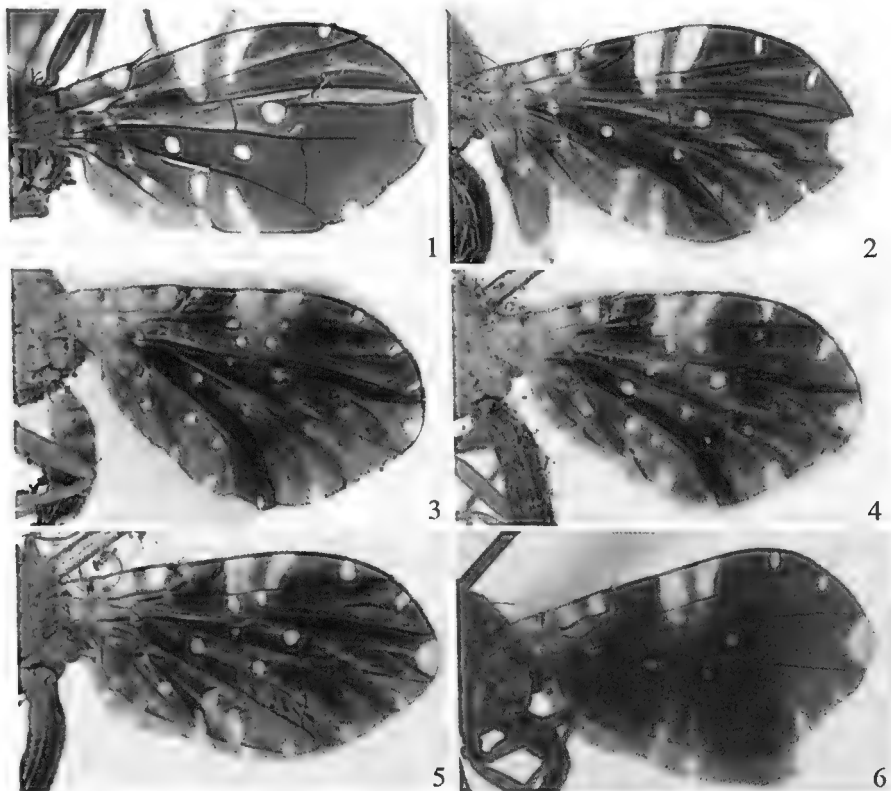
Reevaluation of the morphology and relationships of the four non-African species included in *Bezzina* by Hancock (2001) suggests that they properly belong in *Platensina*, even though their wings are not as broad as is usual in that genus. In all species the scutum is densely greyish pubescent and covered with flattened, subrecumbent, yellow-white setulae, the apical scutellar setae are about half the length of the basal pair and the hyaline indentations in wing cell m are all short, as in typical species of *Platensina*. They differ from *Collessomyia* Hardy & Drew in the frequent presence of a small, marginal hyaline indentation in cell r_{2+3} and in a non-elongate glans lacking a long, flagellum-like and microsetose apical rod. Accordingly, these four species are returned or newly transferred to *Platensina*, as *P. assimilis* (Shiraki), **comb. n.**, *P. quadrula* Hardy, **stat. rev.**, *P. shirouzui* (Ito), **comb. n.** and *P. trimaculata* Hardy & Drew, **stat. rev.** *Platensina amita* Hardy, from Luzon (Philippines), also has a relatively narrow wing and is possibly related.

Platensina fukienica Hering, described from Fujian Province, China (Hering 1939b) is treated here as a new synonym of *P. tetrica* Hering, described from Tamil Nadu, India (Hering 1939a), based on examination of a paratype female and recently collected male of *P. fukienica* from Fujian (in BMNH) in comparison with material of *P. tetrica* from West Malaysia (also in BMNH).

Trypeta voneda Walker, first placed in *Platensina* by Norrbom *et al.* (1999), is treated here as a new synonym of *P. acrostacta* (Wiedemann), based on examination of the lectotype female (Fig. 1) and a paralectotype female in BMNH. Its stated type locality of 'Bahia, Brazil' was regarded as possibly erroneous by Foote (1964) and that is certainly the case. The type labels bear the data 'Brazil, Bahia, ?Collector'. The true type locality is likely to be 'Bengal, India', which is also the type locality of *Trypeta stella* Walker, another synonym of *P. acrostacta* described at the same time (Walker 1849). The small hyaline spot near the apex of cell r_1 present in the lectotype of *P. voneda* occasionally occurs, on one or both wings, in other specimens of *P. acrostacta* from India and Sri Lanka.

Platensina dilatata Hering, *P. dubia* Malloch, *P. malaita* Curran and *P. platyptera* Hendel are removed from synonymy with *P. amplipennis* (Walker) (Fig. 2). These taxa are discussed below.

The only known host record for *Platensina* is of *P. acrostacta* from stem galls on *Ludwigia* (= *Jussiaea*) (Onagraceae) in southern India (Hardy 1973; specimens in BMNH: 2 ♀♀, Kodaguhalli [Kodihalli, Bangalore], 7.v.1963, larvae causing galls on *Jussiaea* sp.).



Figs 1-6. *Platensina* spp., wings: (1) Lectotype female of *P. voneda*, a synonym of *P. acrostacta*; (2) female of *P. ampliennis* from West Java; (3-4) *P. ampla*: (3) female from Papua New Guinea; (4) male from Solomon Islands; (5-6) *P. platyptera*: (5) male from Sarawak; (6) female from Trinity Park, Qld. Photos 1-5 by K. Goodger © Natural History Museum, London.

Platensina ampla de Meijere (Figs 3-4)

Platensina ampla de Meijere, 1914: 217. Type localities Batavia [Jakarta] and Semarang, Java, Indonesia.

Platensina dilatata Hering, 1941b: 63, fig. 11; **syn. n.** Type locality Stephansort [Bogadjim], Astrolabe Bay, Papua New Guinea.

Material examined. PAPUA NEW GUINEA: 1 ♀, Laloki, Central Province, 23.iii.1986, J.W. Ismay (BMNH). SOLOMON ISLANDS: 1 ♂, British Solomons, i.1933, R.J.A.W. Lever (BMNH).

Platensina dilatata, described from Astrolabe Bay in Papua New Guinea (Hering 1941b), is removed from synonymy with *P. amplipennis* and placed as a new synonym of *P. ampla*. This species is distinguished by the presence of two hyaline marginal indentations in cell r_{2+3} and isolation of the hyaline discal spots in that cell. Newly recorded from Solomon Islands.

Platensina amplipennis (Walker) (Fig. 2)

Trypeta amplipennis Walker, 1860: 159. Type locality Makassar, Sulawesi.

Material examined. INDONESIA (SULAWESI): Lectotype ♀, Macassar, Celebes, W.W. Saunders, B.M. 1868-4 (BMNH). INDONESIA (JAVA): 1 ♀, Preanger, Wynkoops Bay, West Java, iii.1935 (BMNH). MALAYSIA (WEST): 1 ♀, Wang Tangga, Perlis, 18.iii.1936, ex FMS Museum (BMNH).

Most records of *P. amplipennis* from countries other than Indonesia and Malaysia (including Australia) belong to *P. platyptera*; others (e.g. Hardy 1973) require confirmation. Length of the apical scutellar setae and wing characters, particularly the shape and orientation of the hyaline indentations in cells $r_1 + r_{2+3}$ and m (c.f. Figs 2-6), separate it from similar species.

Platensina euryptera (Bezzi)

Tephritis euryptera Bezzi, 1913: 162. Type locality Tenasserim, Burma.

Platensina extincta Hering, 1952: 47, fig. 4. Type locality Wai Lekabe, Baing, east Sumba I., Indonesia. Synonymy by Hardy 1988.

Material examined. VIETNAM: 1 ♂, Indo-China, R.V. de Salvaza, 1918-1 (BMNH).

Newly recorded from Vietnam.

Platensina platyptera Hendel, **stat. rev.** (Figs 5-6)

Platensina platyptera Hendel, 1915: 461. Type locality Taihorin, Taiwan.

Platensina malaita Curran, 1936: 29, pl. 1; **syn. n.** Type locality Tai Lagoon, Malaita, Solomon Islands.

Platensina dubia Malloch, 1939: 459; **syn. n.** Type locality Gordonvale, Qld, Australia.

Platensina amplipennis: authors, *nec* Walker, 1860. Misidentifications.

Material examined. AUSTRALIA (QUEENSLAND): 1 ♀, Warnambool St, Trinity Park, Cairns, 16°48'S 145°42'E, 28.iv.2010, J. Olive (AQIS). VANUATU: 1 ♀, Nombur, Gaua, Santa Maria I., Banks Is, 15.x.1922, T.T. Barnard (BMNH); 1 ♂, native garden near Hog Harbour, Elephant I., Espiritu Santo, 0-50', 17.iv.1927, J.R. Baker & Percy Sladen (OUMNH). SOLOMON ISLANDS: 1 ♂, Solomon Is, xi.1932, R.A. Lever (BMNH); 2 ♂♂, Lingatu, Russel I., 26.viii.1936, R.A. Lever (BMNH). INDONESIA (FLORES): 1 ♂, Wae Rana, W. Flores, 26.i.1927 (BMNH). MALAYSIA (SARAWAK): 1 ♀, R. Kapah trib. of R. Tinjah, 5.x.1932, undergrowth, B.M. Hobby & A.W. Moore, Oxford Univ. Expd. (BMNH). BURMA: 1 ♀, Rangoon, 23.xii.[19]04-3.i.[19]05, Brunetti (BMNH).

Platensina platyptera, described from Taiwan (Hendel 1915), is also removed from synonymy with *P. amplipennis*, from which it differs in wing pattern characters and the shorter and weaker apical scutellar setae (about

a quarter length of basals, rather than half). *P. platyptera* closely resembles *P. zodiacalis* (Bezzi) and, like that species, is widespread; however, *P. zodiacalis* lacks apical scutellar setae.

Hardy (1954) also recorded this species from Espiritu Santo (as *P. malaita*) and Hering (1941a) previously recorded the Flores specimen. It also occurs at Tapini in Papua New Guinea (Hardy 1988, as *Pliomelaena* sp. B), Andaman Islands, India (K.J. David pers. comm., photograph examined) and Ryukyu Islands, Japan (Wang 1998, as *P. amplipennis*). Records from Thailand, Laos, Vietnam and Micronesia (Hardy 1973) probably also belong here but confirmation is required; his illustration is of *P. amplipennis*. Illustrations in Hardy and Drew (1996) are also of *P. amplipennis* and the Trinity Park female (Fig. 6) appears to be the first Australian specimen illustrated.

Platensina zodiacalis (Bezzi)

Tephritis zodiacalis Bezzi, 1913: 163. Type locality Calcutta, India.

Material examined. INDIA: 1 ♀, ex Brunetti (BMNH). NEPAL: E. shore of R. Arun below Tumlingtar, Arun Valley, c1800', 23.xii.1961, swept from *Ricinus communis* L. (BMNH). BURMA: 1 ♂, Rangoon, 23.xii.[19]04-3.i.[19]05, Brunetti (BMNH). CHINA: 1 ♂, Xishuangbanna, Yunnan, 650 m, 6.iv.1958, L.Y. Zhang & S.P. Hong (BMNH). THAILAND: 1 ♂, Sathorn Rd, [Bangkok], 26.xi.1933, W.R.S. Ladell (BMNH). SINGAPORE: 1 ♂, Singapore, H.N. Ridley, 99-126 (BMNH).

Newly recorded from Burma and Singapore.

Tribe Tephrellini

***Dicheniotes* Munro, 1938**

Examination of material in BMNH has confirmed the view that all except the type species of *Pediapelta*, the South African *Pediapelta spadicescens* Munro [3 females from Katberg examined], should be transferred to *Dicheniotes*; it differs from all other species included in *Pediapelta* by Munro (1947) and Hancock *et al.* (2003) in significant wing pattern characters (wing with base largely infuscated including middle of cell c, not with base and middle of cell c broadly hyaline; R-M crossvein aligned with middle of basal hyaline indentation across cell r_1 , not between the two; the large hyaline spot in cell r_{4+5} lies on line of outer hyaline indentation across cell r_1 and before, not beyond, line of DM-Cu crossvein), head shape (lower occiput distinctly swollen) and a larger, more robust body. In addition, cell dm is with or without a subapical spot placed just beyond the line of R-M crossvein and the postpronotal lobes are dark fulvous with a fuscous tint to entirely fuscous. The affinities of *P. spadicescens* are uncertain but the dark band in cell c and the position of the hyaline spot in cell r_{4+5} suggest it belongs in tribe Tephritini; unfortunately only females have been recorded.

All other species are referable to *Dicheniotes*, considered here to comprise 19 species, including the following seven new combinations, all transferred from *Pediapelta* [all species examined]: *D. aeneus* (Munro), *D. alexina* (Munro),

D. asmarensis (Munro), *D. enzoria* (Munro), *D. parviguttatus* (Hering), *D. sokotrensis* (Hering) and *D. ternarius* (Loew). One new species is described.

The pale thoracic pubescence or 'dust' varies from fine and sparse to coarse and relatively dense; the postocular setae also vary from black to reddish-brown, yellowish or creamy-white (often mixed). In the examined material, the 'dust' appears coarsest and the postocular setae palest in *D. parviguttatus* and *D. sokotrensis*. Such variation, particularly in the colour of the postocular setae, also occurs in other tephrelline genera such as *Metasphenisca* Hendel and *Pristaciura* Hendel. *Dicheniotes dispar* (Bezzi) has been bred from flowers of *Becium obovatum* (Lamiaceae) and others found associated with, but not bred from, *Ocimum suave* (Lamiaceae) (Munro 1947).

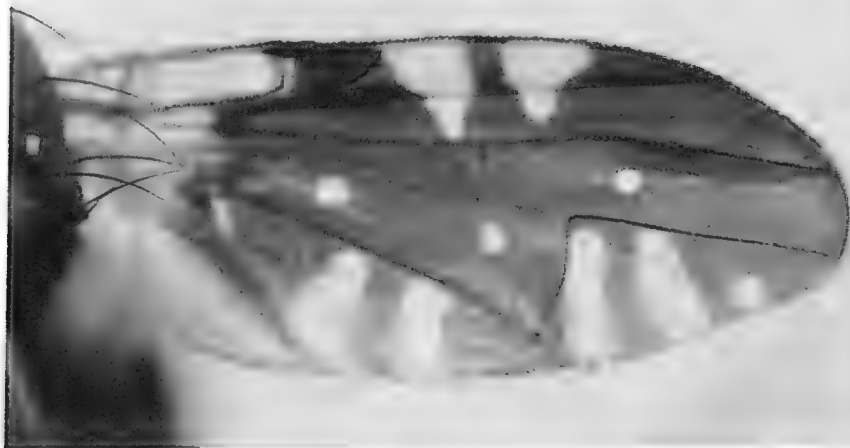


Fig. 7. *Dicheniotes kakamegae* sp. n., wing of holotype female. Photo by K. Goodger
© Natural History Museum, London.

***Dicheniotes kakamegae* sp. n. (Fig. 7)**

Type. Holotype ♀, KENYA: Kakamega Forest, 5200 feet, 20.xii.1970, A.E. Stubbs, B.M. 1972-211 (in BMNH).

Description. Female. Length of body (excluding oviscapae) 3.0 mm, of wing 3.2 mm. Head oval, a little higher than long, largely black with face and antennae fulvous; lower occiput not distinctly swollen; frons brown, paler anteriorly; antennae shorter than face, with 3rd segment apically rounded, arista pubescent; 2 pairs orbital and 2 pairs frontal setae, all black; postocular and genal setae thin and black; ocellar setae as long as frontals; epistome slightly protruding; palpi and labellum fulvous.

Thorax shining black; scutal pubescence very fine, dark and sparse; scutum with a brownish tinge; pleura dark brown, pubescence coarser and pale

ventrally and on lower margin of katepisternum; dorsocentral setae slightly in front of line of supra-alar setae, about half way between supra-alars and suture; apical scutellar setae well developed, nearly as long as basals.

Legs fulvous except fore femora brown, mid and hind femora and basal 2/3 of hind tibiae dark brown to black; mid tibiae with an apical black spine.

Wing (Fig. 7) similar to that of *D. enzoria* but 2nd hyaline indentation in cell r_1 beyond stigma not crossing all of cell r_{2+3} and cell m with an outer hyaline spot present (c.f. *D. aeneus*); both indentations in cell cu_1 crossing cell and of approximately even width (c.f. *D. alexina*). Halteres cream-coloured; squamae with a brownish tinge.

Abdomen shining black with fine, sparse pubescence that is longer, denser and pale ventrally; tergite VI about 0.7 length of tergite V. Oviscape shining black, length 0.6 mm, about as long as tergites IV-VI combined, narrowing posteriorly; aculeus fulvous, apically acute, narrow and needle-like.

Etymology. Derived from the type locality.

Distribution. Known only from the Kakamega Forest in western Kenya.

Comments. This species resembles *D. enzoria* and, like that species, the scutum has no discernible 'dust'. It differs from *D. enzoria* in the slightly broader and less elongate wing coupled with wing pattern differences, and from both it and *D. alexina* in having 3 hyaline spots in cell m.

Key to *Platensina* species

Modified from Hardy (1973, 1974, 1988), Hardy and Drew (1996) and Wang (1998) by combination and inclusion of subsequently assigned species. An additional Asian species described by Wang (1998), plus the African species included by Munro (1947) and Norrbom *et al.* (1999), were transferred to *Pseudafreutreta* Hering (in tribe Pliomelaenini) by Hancock (2001) and Hancock *et al.* (2003) respectively.

- 1 Wing cell c and basal two-thirds of stigma hyaline; hyaline marginal spots (including 2 in cell m and 3 in cell cu_1) present but pale discal spots absent; head with 1-2 pairs of frontal setae; wing relatively narrow, not distinctly angled posteriorly near apex of cell cu_1 [Philippines (Luzon)] ...
..... *P. amita* Hardy, 1974
- Wing cell c not entirely hyaline; stigma with at most a hyaline basal spot; pale discal spots usually present; head with 3 pairs of frontal setae; wing often relatively broad and angled posteriorly near apex of cell cu_1 2
- 2 Wing without hyaline discal or marginal spots or indentations except for a pair of small costal spots at bases of stigma and cell r_1 adjacent to veins Sc and R_1 respectively; wing broad and almost circular beyond basal third, the apex evenly rounded and entirely dark [Philippines (Luzon)] ...
..... *P. bezzii* Hardy, 1974

- Wing usually with hyaline discal and submarginal spots or indentations; wing often broad but distinctly longer than wide, the apex at least slightly produced and with at least a hyaline spot at apex of cell r_{4+5} 3
- 3 Wing with hyaline apical spot extending across veins R_{4+5} and M; cell cu_1 with 2 elongate hyaline marginal indentations; cell r_1 without a hyaline preapical spot [Taiwan; male unknown] *P. apicalis* Hendel, 1915
- Not as above; if hyaline apical spot crosses veins R_{4+5} and M and cell cu_1 with 2 elongate hyaline indentations, then apical spot extends at least halfway into cells r_{2+3} and m and cell r_1 with a hyaline preapical spot 4
- 4 Wing with hyaline apex a crescentic band from cell r_{2+3} to cell m, crossing apices of both veins R_{4+5} and M; cell dm without a hyaline subapical spot 5
- Wing with hyaline apex an oval or quadrate spot confined to cell r_{4+5} ; cell dm normally with a hyaline subapical spot 7
- 5 Male wing without hyaline spots or indentations apart from a small indentation from costa in cell r_1 at apex of vein R_1 and the apical band; female wing cell r_1 with 2 elongate hyaline indentations from costa and a small preapical spot, cell dm with a hyaline basal spot, cell r_{4+5} without a basal spot and cell cu_1 with 1 or 2 small round indentations from wing margin [China (Yunnan)] *P. nigripennis* Wang, 1998
- Male wing cell r_1 with 2 narrow or 1 broad hyaline indentation from costa beyond stigma and a small preapical spot, cells r_{4+5} and dm either with or without distinct basal spots and cell cu_1 with a pair of short or elongate indentations from posterior margin; female unknown 6
- 6 Male wing cell r_1 with 2 narrow hyaline indentations crossing vein R_{2+3} into cell r_{2+3} , cells r_{4+5} and dm each with a hyaline basal spot and cell cu_1 with a pair of elongate transverse indentations from wing margin almost reaching vein Cu_1 [NE Burma] *P. alboapicalis* Hering, 1938
- Male wing cell r_1 with 1 broad hyaline indentation crossing vein R_{2+3} into cell r_{2+3} , cells r_{4+5} and dm without hyaline basal spots and cell cu_1 with a pair of small round indentations from wing margin [Australia (NE Queensland)] *P. parvipuncta* Malloch, 1939
- 7 Wing with 2 elongate hyaline indentations from costa in cell r_1 , both crossing vein R_{2+3} into cell r_{2+3} , no marginal preapical hyaline spots in cell r_{2+3} , large hyaline spots near base of cell r_{4+5} and near base and apex of cell dm, 1 marginal spot in cell m near apex of vein Cu_1 , 2 indentations in cell cu_1 and 1 or 2 spots along margin of anal lobe; stigma black, without a hyaline basal spot 8
- Wing markings not as above; marginal preapical hyaline spots in cell r_{2+3} usually present; cell m usually with 2 or 3 hyaline marginal spots; stigma often with a hyaline basal spot 9

- 8 Male with face largely black in male, yellow in female; hyaline indentations in cell cu_1 of approximately equal length, almost crossing cell but the basal spot sometimes medially divided; basal marginal hyaline spot in anal lobe much smaller than second marginal spot or absent [India, Sri Lanka, Bangladesh, Burma, China (Yunnan), Thailand and Cambodia; *Ensina guttata* Wiedemann, 1824, *Trypeta stella* Walker, 1849 and *Trypeta voneda* Walker, 1849 are regarded as synonyms] *P. acrostacta* (Wiedemann, 1824)
- Male with face yellow, female unknown; basal hyaline indentation in cell cu_1 much smaller than second indentation, not almost crossing cell; the two marginal hyaline spots in anal lobe of approximately equal size [India (Maharashtra)] *P. fulvifacies* Hering, 1941
- 9 Wing cell r_1 with a large, single hyaline indentation in basal portion that crosses vein R_{2+3} and almost all of cell r_{2+3} ; cells m and cu_1 each with a single marginal indentation, that in cell cu_1 crossing cell [Philippines (Luzon)] *P. aptata* Hardy, 1974
- Wing cell r_1 with no or 2 hyaline indentations in basal portion, the outer sometimes reduced to a rounded spot or largely united with the basal one; cells m and cu_1 not both with a single marginal indentation 10
- 10 Wing cell r_{2+3} with 2 hyaline marginal indentations from costa; cell r_1 with indentations in basal portion often medially constricted or reduced to marginal spots and spots in cell r_{2+3} below them isolated [Indonesia (Java, Ambon), Papua New Guinea and Solomon Islands; *P. dilatata* Hering, 1941 is regarded as a new synonym] *P. ampla* de Meijere, 1914
- Wing cell r_{2+3} with at most a single hyaline marginal indentation from costa; cell r_1 with indentations in basal portion distinct and crossing cell, reduced to isolated costal spots or absent 11
- 11 Two scutellar setae, the apical pair absent [India (Bihar, Karnataka, West Bengal: type locality), Nepal, Sri Lanka, Bangladesh, Burma. China (Yunnan, Guangdong, Hainan), Thailand, Laos, Cambodia, Philippines (Luzon, Mindoro), West Malaysia, Singapore, Indonesia (Java, Maluku) and Australia (NT, Qld)] *P. zodiacalis* (Bezzi, 1913)
- Four scutellar setae, the apical pair distinct 12
- 12 Wing relatively broad, distinctly angled posteriorly near apex of cell cu_1 ; cell m with at most 2 hyaline marginal indentations 13
- Wing relatively narrow, evenly rounded posteriorly and not distinctly angled near apex of cell cu_1 ; cell m with 2 or 3 hyaline marginal indentations 18
- 13 Wing cell r_{4+5} with a very small hyaline spot at apex [Indonesia (Java, Sumba); type species of *Platensina*] *P. sumbana* Enderlein, 1911

- Wing cell r_{4+5} with a broad or elongate hyaline spot at apex, crossing all or most of cell 14
- 14 Wing often without hyaline spots except along margin, the discal area at most with hyaline spots in cells dm and base of r_{4+5} beyond R-M crossvein; second hyaline indentation in basal portion of cell r_1 narrow and often united with basal one, leaving an isolated dark costal spot; anal lobe brown, the hyaline marginal spots absent or vestigial [S Burma, Thailand, Vietnam, Indonesia (Sumba); *P. extincta* Hering, 1952 is regarded as a synonym] *P. euryptera* (Bezzi, 1913)
- Wing usually with distinct hyaline or subhyaline spots, at least in cells dm and base of r_{4+5} ; hyaline indentations in basal portion of cell r_1 distinct, reduced or absent; anal lobe with hyaline marginal spots usually distinct 15
- 15 Wing with discal spots often subhyaline; cell r_1 with 0-2 small hyaline indentations from costa in basal portion beyond stigma, often neither partly fused nor crossing cell (especially in males); cell cu_1 with 3 small, isolated, hyaline marginal spots and with or without additional small, isolated discal spots [India (Tamil Nadu), China (Guangxi, Fujian), Taiwan, Vietnam and West Malaysia; *P. fukienica* Hering, 1939 is regarded as a new synonym] *P. tetrica* Hering, 1939
- Wing with distinct discal hyaline spots; hyaline indentations in basal portion of cell r_1 with at least the inner one broad and crossing cell in both sexes; cell cu_1 with 2 or 3 hyaline indentations, the basal pair normally elongate but often medially divided into 2 separate spots 16
- 16 Wing cell m with at most 1 small hyaline marginal spot; cell cu_1 with 2 undivided indentations almost crossing cell [Thailand, Cambodia and Vietnam] *P. intacta* Hardy, 1973
- Wing cell m with 2 hyaline marginal spots; cell cu_1 with 2 or 3 hyaline marginal spots, the basal pair short or divided into separate spots, the outer spot often reduced or absent 17
- 17 Basal hyaline indentations in wing cells r_1 and r_{2+3} more or less convergent, those in r_{2+3} aligned with those in r_1 ; hyaline apical spot relatively narrow and filling entire apex of cell r_{4+5} ; basal hyaline indentation in cell m narrow, elongate and perpendicular; anal lobe with hyaline marginal spots vestigial or absent; apical scutellar setae distinct, about half length of basals [?S Thailand, West Malaysia, ?Singapore and Indonesia (Java, Sulawesi)] *P. amplipennis* (Walker, 1860)
- Basal hyaline indentations in wing cells r_1 and r_{2+3} more or less parallel, those in r_{2+3} small and off centre with those in r_1 ; hyaline apical spot relatively broad and not filling entire apex of cell r_{4+5} ; basal hyaline indentation in cell m often short and broad; anal lobe with hyaline

- marginal spots round and distinct; apical scutellar setae weak, about a quarter length of basals [India (Utranchal, Andaman Is), Burma, Japan (Ryukyu Is), Taiwan, Northern Marianas, Guam, Micronesia, ?Thailand, ?Laos, ?Vietnam, Malaysia (Sarawak), Indonesia (Flores), Papua New Guinea (Admiralty Is, Central Province), Solomon Is (Malaita, Russel), Vanuatu (Espiritu Santo, Banks) and Australia (Queensland); *P. malaita* Curran, 1936 and *P. dubia* Malloch, 1939 are regarded as synonyms] ...
 *P. platyptera* Hendel, 1915, **stat. rev.**
- 18 Wing cells m and cu₁ each with 3 hyaline indentations from margin, those in cell cu₁ all small and isolated 19
- Wing cell m with 2 and cell cu₁ with 2 or 3 hyaline indentations from margin, often with at least one of those in cell cu₁ elongate and crossing most of cell 20
- 19 Wing cell dm with 3 rounded hyaline spots; cell m with 2 hyaline spots in anterobasal half [Australia (NE Queensland)]
 *P. trimaculata* Hardy & Drew, 1996
- Wing cell dm with 2 rounded hyaline spots; cell m with 1 hyaline spot in anterobasal half [Japan (Ryukyu Is), Taiwan and China (Sichuan, Guangxi)] *P. assimilis* (Shiraki, 1968), **comb. n.**
- 20 Wing cell cu₁ with 3 hyaline indentations from margin, with at least the basal pair broad and crossing cell; anal cell with a transverse hyaline indentation crossing vein Cu₂+A₁ into cell cu₁; face with silvery spots in male [India, Thailand, Cambodia, Vietnam] *P. quadrula* Hardy, 1973
- Wing cell cu₁ with 2 or 3 narrow hyaline indentations from margin, the basal pair constricted or divided into two separate spots; anal cell with only small, round marginal hyaline spots; face without silvery spots [Japan (Ryukyu Is) and China (Sichuan); a male from Indonesia (West Papua), illustrated by Hardy (1988) as *Pliomelaena* sp. A, is possibly this species] *P. shirouzui* (Ito, 1984), **comb. n.**

Key to *Dicheniotes* species

Modified from Munro (1947) by inclusion of subsequently described or assigned species. * = new country records based on material in BMNH.

- 1 Stigma with a subhyaline basal spot from costa; apex of cell r₂₊₃ with a hyaline spot near tip of vein R₂₊₃; outer of 3 hyaline indentations in cell m reduced to an isolated, rounded, submarginal spot; postocular setae largely white 2
- Stigma without a subhyaline spot from costa; apex of cell r₂₊₃ with or without a hyaline spot near tip of vein R₂₊₃; outer of 3 hyaline indentations in cell m, when present, often elongate and crossing most of cell; postocular setae pale or dark 4

- 2 Wing cell m with middle marginal spot large and quadrate; cell cu_1 with 2 hyaline spots, the basal spot large and quadrate; cell r_1 without an additional subapical spot crossing cell; submarginal spot in cell r_{2+3} large and situated just below tip of vein R_{2+3} ; female oviscapae as long as abdomen [Kenya] *D. polypsilus* (Bezzi, 1924)
- Wing cell m with middle marginal spot small and round; cell cu_1 with 3 hyaline spots, the basal spot divided into two; cell r_1 with an additional subapical spot crossing cell; submarginal spot in cell r_{2+3} small and situated nearer midline of cell; female oviscapae much shorter than abdomen 3
- 3 Wing cell r_1 with inner hyaline indentation narrow and strap-like and the middle indentation small and confined to costal margin [Ethiopia]
..... *D. parviguttatus* (Hering, 1952), **comb. n.**
- Wing cell r_1 with inner hyaline indentation broad and subquadrate and the middle indentation large and quadrate [Kenya, Tanzania, Saudi Arabia and Yemen] *D. multipunctatus* Merz & Dawah, 2005
- 4 Wing cell m with 2 large hyaline spots, the inner one marginal, the outer submarginal; cell r_{2+3} with 2 small hyaline spots near tip of vein R_{2+3} ; postocular setae largely white [Sokotra]
..... *D. sokotrensis* (Hering, 1939), **comb. n.**
- Wing cell m mostly brown or with 2 or 3 hyaline indentations, the outer often reduced to a small, rounded spot, if 2 then both are marginal and cell r_{2+3} without a small hyaline spot near tip of vein R_{2+3} ; postocular setae pale or dark 5
- 5 Wing cell r_{2+3} with a round, hyaline spot near the tip of vein R_{2+3} that does not reach the wing margin; cell m with 3 hyaline indentations from wing margin, the outer one often reduced to a small spot; cell dm with a pair of isolated and well separated hyaline spots 6
- Not as above; wing cell r_{2+3} without a round, hyaline spot near the tip of vein R_{2+3} ; cell m usually with at most 2 hyaline indentations from wing margin; cell dm sometimes without a pair of isolated hyaline spots 9
- 6 Outer hyaline indentation from costa in cell r_1 confined to that cell, not crossing vein R_{2+3} [Sudan, Saudi Arabia and Yemen]
..... *D. angulicornis* (Hendel, 1931)
- Outer hyaline indentation from costa in cell r_1 crossing vein R_{2+3} at least half way into cell r_{2+3} 7
- 7 Outer hyaline indentation in cell m elongate and crossing most of cell [Uganda] *D. acclivis* Munro, 1947
- Outer hyaline indentation in cell m no more than a small, rounded, marginal or submarginal spot 8

- 8 Labellum greatly enlarged; wing cell r_{2+3} with a hyaline basal spot near base of stigma; femora blackened [Uganda and Kenya] *D. turgens* Munro, 1947
- Labellum not greatly enlarged; wing cell r_{2+3} without a hyaline spot near base of stigma; fore femur often fulvous, others black [Kenya and Tanzania] *D. aeneus* (Munro, 1947), **comb. n.**
- 9 Wing cell m with 3 elongate hyaline indentations, the outer 2 both crossing vein M into and across cell r_{4+5} [Eritrea] *D. asmarensis* (Munro, 1955), **comb. n.**
- Wing cell m with at most 2 elongate hyaline indentations (sometimes mostly brown) and with or without a small outer spot 10
- 10 Femora fulvous; wing cell m with outer hyaline indentation broadly crossing vein M into cell r_{4+5} to or almost to vein R_{4+5} ; cell cu_1 with 2 hyaline indentations 11
- Femora largely black; wing cell m with outer hyaline indentation often confined to cell, if crossing vein M into cell r_{4+5} then cell cu_1 with a single broad hyaline indentation 13
- 11 Wing cell dm without a pair of hyaline spots [Kenya] *D. sexfissatus* (Becker, 1909)
- Wing cell dm with a pair of hyaline spots 12
- 12 Wing cell dm with a pair of isolated and well separated hyaline spots [Tanzania, Zimbabwe and South Africa; records from Namibia are errors (Hancock 2000); *Brachyaciura discoguttata* Hering, 1941 is regarded as a synonym] *D. distigma* (Bezzi, 1924)
- Wing cell dm with a pair of large hyaline spots united with the indentations in cell cu_1 [Democratic Republic of Congo, Uganda, Kenya and Tanzania] *D. erosa* (Bezzi, 1924)
- 13 Sexes distinctly dimorphic; wing largely brown with diffuse longitudinal pale streaks and patches (some males) or cell r_1 with 1 broad or 2 transverse hyaline indentations from costa, cell cu_1 with a single, broad hyaline indentation extending broadly into cell dm in females, not in males; cell m with 2 hyaline indentations, the outer one crossing vein M into cell r_{4+5} and cell dm without a pair of isolated hyaline spots 14
- Sexes not distinctly dimorphic; wing cell r_1 with 2 narrow hyaline indentations from costa; cell cu_1 with 2 narrow hyaline indentations not extending into cell dm; cell m with 2 narrow hyaline indentations and at most a small outer spot, none crossing vein M into cell r_{4+5} ; cell dm with a pair of well separated hyaline spots 15

- 14 Wing cell m almost entirely filled (including apex at tip of vein M) by 2 broad hyaline indentations separated by at most a dark transverse band; the 2 hyaline indentations from costa in cells r_1 and r_{2+3} combined into a single broad band in males, separated in females [South Africa; type species of *Dicheniotes*] *D. dispar* (Bezzi, 1924)
- Wing cell m largely brown with at most a pale anterobasal streak and a diffuse posterobasal spot and cell cu_1 with hyaline indentation divided into 2 separate spots (males), or with the outer of the 2 hyaline indentations in cell m narrow and not almost filling apex of cell (females) [Eritrea and Ethiopia (2♂♂, 3♀♀, Simien, ravine on W side of Mai Shaba valley, 9000', 14.xii.1952, H. Scott*)] *D. tephronotus* (Bezzi, 1908)
- 15 Wing cell m with inner indentation more or less parallel with DM-Cu crossvein and with a small rounded outer spot in addition to basal and medial indentations [Kenya, Tanzania, Yemen (2♂♂, Wadi Doreija, W of Dhala, 4500', xi.1937*) and South Africa] *D. katonae* (Bezzi, 1924)
- Wing cell m with inner indentation oblique, converging with DM-Cu crossvein anteriorly and meeting wing margin posteriorly beyond apex of vein Cu_1 and with or without a small rounded outer spot 16
- 16 Wing cell m with 3 hyaline indentations, the outer spot present [Kenya] *D. kakamegae* sp. n.
- Wing cell m with only 2 hyaline indentations, the outer spot absent 17
- 17 Wing cell r_1 with the outer hyaline indentation not crossing vein R_{2+3} into cell r_{2+3} [Kenya, Zimbabwe and South Africa; one record from Australia (SE Queensland), presumably introduced (Hancock and Drew 2003)] *D. ternarius* (Loew, 1861), **comb. n.**
- Wing cell r_1 with the outer hyaline indentation crossing vein R_{2+3} into cell r_{2+3} 18
- 18 Wing with line of DM-Cu crossvein meeting costa on the outer hyaline indentation in cell r_1 or close to its outer margin; squamae with a brown to blackish tinge [Uganda] *D. enzoria* (Munro, 1947), **comb. n.**
- Wing with line of DM-Cu crossvein meeting costa well beyond the outer hyaline indentation in cell r_1 , at least its width away; squamae yellow; a row of 3 hyaline discal spots in cells r_{2+3} and r_{4+5} present or absent [Zimbabwe and South Africa (1♂, Eshowe, KwaZulu-Natal, vi.1926, R.E. Turner*)] *D. alexina* (Munro, 1947), **comb. n.**

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**A NEW SPECIES OF THE SUBGENUS *CAMPOMYRMA* WHEELER
OF THE GENUS *POLYRHACHIS* FR. SMITH FROM THE
AUSTRALIAN CAPITAL TERRITORY
(HYMENOPTERA: FORMICIDAE: FORMICINAE)**

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Abstract

Polyrhachis smithersi, a new species of the *hexacantha* complex of the subgenus *Polyrhachis* (*Campomyrma*) Wheeler, is described from the Australian Capital Territory. A key distinguishing it from the three other described species of the complex is provided. All four species are illustrated and their distribution data summarised.

Introduction

The *hexacantha* complex of *Polyrhachis* (*Campomyrma*) Wheeler comprises four species: *P. fuscipes* Mayr, *P. hexacantha* (Erichson), *P. semipolita* André and a new species described below. All four are rather similar and share many characters, including a distinctly slender mesosoma, a propodeal dorsum with two slender, posteriorly directed spines and a petiole with elongated lateral spines and a pair of shorter intercalary spines or teeth. Taylor (1989) also considered these species to be closely related and 'similar and distinguished primarily by sculptural differences. *P. fuscipes* is less regularly and coarsely sculptured than *P. hexacantha*, while *P. semipolita* has all body surfaces remarkably smooth and strongly reflective. The 3 species seem to be similarly distributed (except that *P. hexacantha* ranges north to the New England Tableland) and are likely closely sympatric in parts of southeastern Australia and Tas.' [Tasmania]. His opinion on their sympatric association has been confirmed, with three species of the complex collected by the author in close proximity at the type locality of the new species, Smokers Gap in the Australian Capital Territory.

Methods

Photographs of the specimens were taken with a digital camera attached to a stereomicroscope and processed using Auto-Montage (Syncroscopy, Division of Synoptics Ltd, USA) and Adobe Photoshop CS2 (Adobe Systems Inc., USA). Images of *P. smithersi* sp. n. depict the holotype, those of *P. hexacantha*, *P. fuscipes* and *P. semipolita* depict the types or type-compared specimens from the ANIC collection. All specimens were photographed by Dr Steve O. Shattuck (ANIC).

The standard measurements and indices mainly follow those of Kohout (2008): TL = Total length (the necessarily composite measurement of the outstretched length of the entire ant measured in profile); HL = Head length (the maximum measurable length of the head in perfect full face view, measured from the anterior-most point of the clypeal border or teeth to the

posterior-most point of the occipital margin); HW = Head width (width of the head in perfect full face view, measured immediately in front of the eyes); CI = Cephalic index ($HW \times 100/HL$); SL = Scape length (length of the antennal scape, excluding the condyle); SI = Scape index ($SL \times 100/HW$); PW = Pronotal width (greatest width of the pronotal dorsum, measured behind the pronotal teeth); MTL = Metathoracic tibial length (maximum measurable length of the tibia of the hind leg). All measurements were taken using a Zeiss (Oberkochen) SR stereomicroscope at 20x and 32x magnifications with an eyepiece graticule calibrated against a stage micrometer. All measurements are expressed in millimetres (mm).

Abbreviations. General: acc. – accession/s; ACT – Australian Capital Territory; for. – forest; N.P. – National Park; NSW – New South Wales; Rd – Road; rf. – rainforest; sclero. – sclerophyll forest; TAS – Tasmania; VIC – Victoria; w – worker/s.

Institutions (with names of cooperating curators): AMSA – Australian Museum, Sydney, NSW, Australia (Drs D. Britton, D. Smith); ANIC – Australian National Insect Collection, CSIRO Entomology, Canberra, ACT, Australia (Dr S.O. Shattuck); BMNH – The Natural History Museum, London, UK (B. Bolton, S. Reider); CASC – California Academy of Sciences, San Francisco, CA, USA (Dr B.L. Fisher); MCZC – Museum of Comparative Zoology, Harvard University, Cambridge, MA, USA (Dr S.P. Cover); MNHU – Museum für Naturkunde, Humboldt-Universität, Berlin, Germany (Dr F. Koch); MVMA – Museum Victoria, Melbourne, VIC, Australia (Dr K. Walker); NHMW – Naturhistorisches Museum, Wien, Austria (Drs H. Zettel, D. Zimmermann); OXUM – Hope Entomological Collections, University Museum, Oxford, UK (Dr D.J. Mann); QMBA – Queensland Museum, Brisbane, QLD, Australia (Dr C.J. Burwell); ZMSG – Zoologische Staatssammlung, München, Germany (Dr E. Diller).

Systematics

Genus *Polyrhachis* Fr. Smith, 1857

Polyrhachis Fr. Smith, 1857: 58. Type species: *Formica bihamata* Drury, 1773, by original designation.

Subgenus *Campomyrma* Wheeler, 1911

Campomyrma Wheeler, 1911: 860 (as subgenus of *Myrma* Billberg, 1820 = *Polyrhachis* Fr. Smith, 1857). Type species: *Polyrhachis clypeata* Mayr, 1862 (junior synonym of *Polyrhachis exercita* Walker, 1859), by original designation.

Key to workers of *P. hexacantha* complex

- 1 Smaller species ($HL < 1.81$); lateral petiolar spines only weakly divergent in dorsal view, forming a continuous line with sides of petiolar node (Fig. 2) *P. smithersi* sp. n.
- Larger species ($HL > 1.95$); lateral petiolar spines widely divergent, strongly extending laterally before curving posteriorly (e.g. Fig. 9) 2

- 2 Body very smooth, highly polished *P. semipolita* André
- Body finely sculptured 3
- 3 Dorsum of mesosoma very finely and somewhat longitudinally striate; sculpturation of head distinctly finer, semipolished; intercalary spines of petiole only moderately long (Figs 6-7) *P. fuscipes* Mayr
- Dorsum of mesosoma regularly reticulate-punctate, opaque; intercalary spines of petiole distinctly longer (Figs 9, 11-12) *P. hexacantha* (Erichson)

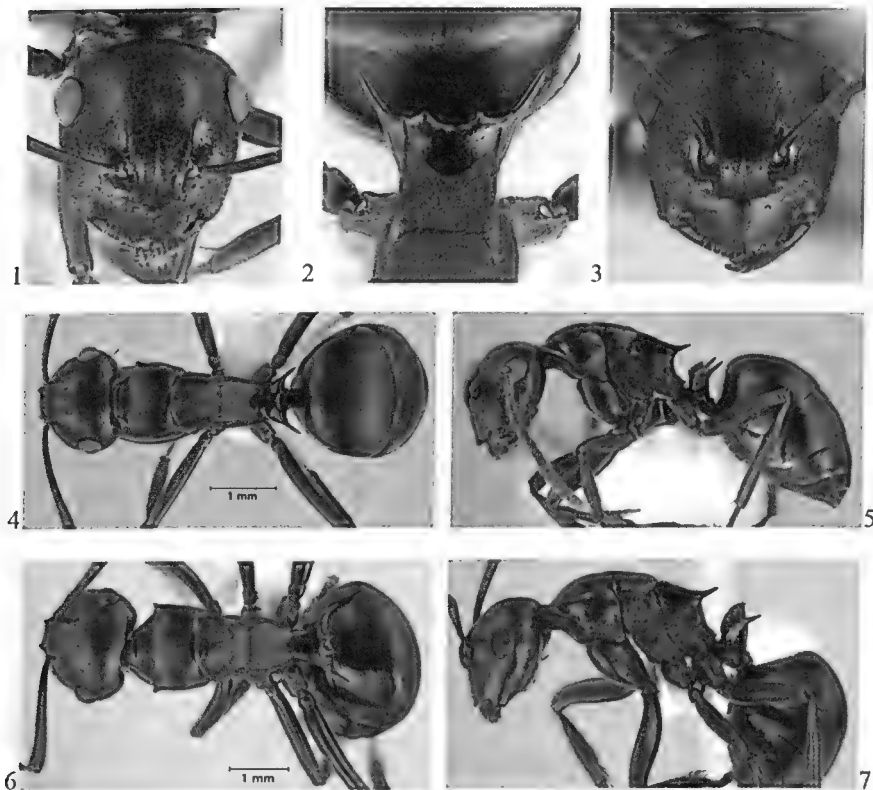
***Polyrhachis smithersi* sp. n.**

(Figs 1-2, 4-5)

Types. *Holotype* worker: AUSTRALIAN CAPITAL TERRITORY, Smokers Gap, Corin Dam Rd., 35°31'S, 148°54'E, 1240 m, 18-19.ii.2001, dry open forest, at night, R.J. Kohout acc. 01.3. *Paratypes*: 9 workers, queen, data as for holotype; 7 workers, as for holotype except 28-29.x.1973, R.J. Kohout acc. 73.138; 7 workers, as for holotype except 20.i.1982, R.J. Kohout acc. 82.40. Type distribution: Holotype, 5 paratype workers and paratype queen in ANIC; 8 paratype workers in QMBA; 2 paratype workers each in AMSA, BMNH, CASC, MCZC and MVMA.

Description. Worker. Dimensions (holotype cited first): TL c. 7.41, 6.60-7.41; HL 1.81, 1.65-1.81; HW 1.53, 1.37-1.53; CI 84, 81-85; SL 1.87, 1.78-1.87; SI 122, 122-134; PW 1.12, 1.06-1.15; MTL 2.18, 2.00-2.18 (6 measured).

Mandibles with 5 teeth. Anterior clypeal margin widely truncate medially, truncate portion somewhat irregularly denticulate and flanked by distinct angles. Clypeus in profile weakly concave, with median carina distinctly raised towards anterior and basal margins. Frontal triangle distinctly impressed; frontal carinae sinuate with narrowly and weakly raised margins; central area relatively wide with distinct frontal furrow. Sides of head in front of eyes rounding towards mandibular bases in weakly convex line; behind eyes sides rounding onto evenly convex occipital margin. Eyes convex, in full face view clearly breaking lateral cephalic outline. Ocelli lacking, position indicated by shallow pits in cephalic sculpture. Mesosomal dorsum elongated; pronotal dorsum with distinct humeral teeth; lateral margins evenly rounded into distinctly impressed promesonotal suture. Mesonotum with lateral margins distinctly converging towards rather flat, metanotal groove. Propodeal margins subparallel, terminating posteriorly in obliquely raised, subparallel, acute spines; propodeal dorsum flat, descending abruptly in medially uninterrupted line into steeply concave declivity. Petiole in side view with anterior and posterior faces virtually parallel from base; dorsum armed with slender, strongly raised, divergent and acute lateral spines; bases of spines continuous medially onto narrow dorsum and merging into two widely separated, blunt intercalary teeth. Anterior face of first gastral segment only weakly concave, widely rounding onto dorsum.



Figs 1-7. *Polyrhachis* (*Campomyrma*) spp: (1-2, 4-5) *P. smithersi* sp. n.; (3, 6-7) *P. fuscipes* Mayr. (1, 3) head in full face view; (2) petiole in front view; (4, 6) dorsal view; (5, 7) lateral view.

Mandibles finely striate at bases, rather irregularly rugose towards masticatory borders with shallow pits. Head rather finely, dorsum of mesosoma more coarsely reticulate-punctate, with former somewhat semipolished; sides of mesosoma very finely reticulate-wrinkled. Gaster finely sculptured, opaque; sculpturation somewhat finer and semipolished in some specimens.

Mandibles with numerous suberect, golden hairs near masticatory borders. Anterior clypeal margin with a few long setae medially; clypeus and frontal carinae with paired, medium length, golden hairs; hairs absent from vertex, dorsum of mesosoma, petiole and most of gastral dorsum. Several longer, golden, semierect hairs on apex and venter of gaster; occasional erect hairs on venter of coxae and fore femora. Closely appressed pubescence very sparingly distributed on various dorsal surfaces, notably on head and gaster.

Black; mandibles, except teeth, distinctly orange-red; legs orange-red to reddish-brown, coxae and tarsi a shade darker. Antennae medium reddish-brown; funiculi reddish-brown at base, with segments progressively lighter towards apices. Gaster reddish-brown with margins of segments lined a shade darker.

Queen. Dimensions: TL c. 7.51; HL 1.65; HW 1.37; CI 83; SL 1.68; SI 123; PW 1.28; MTL 1.96 (1 measured).

The single available queen is rather small, about the size of a small worker. However, it displays the usual characters identifying full sexuality, including three ocelli, complete thoracic structure and wings. Pronotal humeri bluntly angular; mesoscutum virtually as long as wide in dorsal view with lateral margins strongly converging anteriorly into rather narrowly rounded anterior margin; median line distinct; parapsides flat; mesoscutum in profile with relatively low anterior face rounding onto flat dorsum. Mesoscutellum flat, not elevated above dorsal plane of mesosoma. Propodeal dorsum weakly convex, descending into steep, weakly concave declivity in medially uninterrupted line; propodeal spines shorter than in worker, weakly divergent. Petiole virtually identical to that in worker, except for absence of intercalary teeth. Sculpturation of body, pilosity, pubescence and colour virtually as in worker.

Male and immature stages unknown.

Etymology. It is a pleasure to name this species for the late Courtenay Smithers, a generous and productive entomologist who left a lasting legacy of insect studies in Australia.

Remarks. *Polyrhachis smithersi* is so far known only from the type locality, with all specimens collected foraging at night on *Eucalyptus* tree trunks in open forest.

***Polyrhachis fuscipes* Mayr, 1862**

(Figs 3, 6-7)

Polyrhachis fuscipes Mayr, 1862: 679. Holotype worker. Type locality: TASMANIA (as Van Diemensland), NHMW.

Polyrhachis fuscipes Mayr; Roger, 1863: 9. Junior synonym of *P. hexacantha*.

Polyrhachis fuscipes Mayr; Dalla Torre, 1893: 263. Junior synonym of *P. hexacantha*.

Polyrhachis hexacantha subsp. *fuscipes* Mayr; Emery, 1925: 179. Combination in *P. (Campomyrma)* and revived from synonymy as subspecies of *P. hexacantha*.

Polyrhachis fuscipes Mayr; Taylor and Brown, 1985: 134. Revived status as species.

Polyrhachis semipolita subsp. *hestia* Forel, 1911: 295. Holotype worker. Type locality: Australia (Bates), ZMSG (examined).

Polyrhachis fuscipes Mayr; Taylor, 1989: 23. Senior synonym of *P. hestia*.

Additional material examined. NEW SOUTH WALES (including Australian Capital Territory): Thredbo, 30.ii.1982 (A.N. Andersen) (w); 12 km of Kanangra Walls N.P., 2.ii.1977, sclero. (B.B. Lowery) (w); Smokers Gap, 35°31'S, 148°54'E, 1240 m, 28-29.x.1973, dry open forest, at night (R.J. Kohout acc. 73.139) (w); ditto, 20.i.1982 (RJK acc. 82.40) (w); ditto, 18-19.ii.2001 (RJK acc. 01.8) (w); Jenolan Caves (J.C. Wilburt) (w). VICTORIA: Mt Oberon, Wilson's Promotory, 24.ii.1982 (A.N. Andersen) (w); Forrest (H.W. Davey) (w); Victoria (no further data) (w). TASMANIA: 15 km W of Swansea, xi.2003 (N. Meeson) (w); Hobart (A.M. Lea) (w).

Worker. Dimensions: TL c. 7.81-8.87; HL 1.96-2.12; HW 1.62-1.81; CI 81-85; SL 2.10-2.37; SI 126-136; PW 1.28-1.47; MTL 2.43-2.65 (9 measured).

Remarks. *Polyrhachis fuscipes* is known from the mountainous parts of southeastern NSW and ACT, and south through the Victorian Alps to Tasmania. It was collected in sympatry with *P. smithersi* and *P. hexacantha* at Smokers Gap in ACT.

***Polyrhachis hexacantha* (Erichson, 1842)**

(Figs 8-9, 10-11)

Formica hexacantha Erichson, 1842: 260. Syntype worker, queen (lectotype and paralectotype designated by Taylor, 1989: 24). Type locality: TASMANIA, ?Woolnorth (?A. Schayer), MNHU (worker examined).

Polyrhachis hexacantha (Erichson); Fr. Smith, 1858: 74. Combination in *Polyrhachis*.

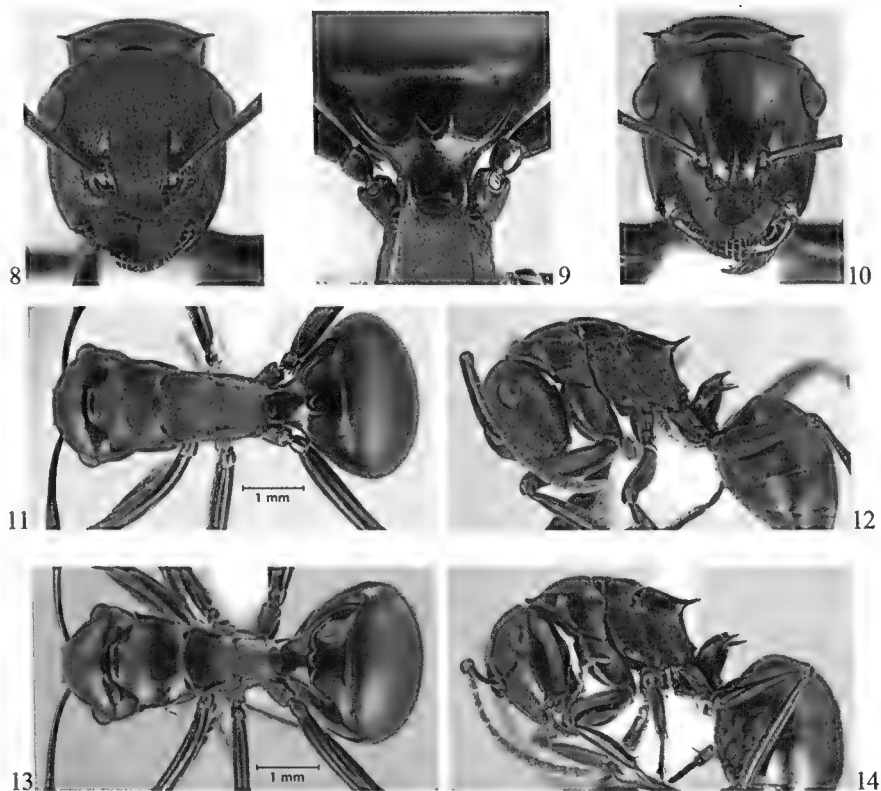
Polyrhachis hexacantha (Erichson); Emery, 1925: 179. Combination in *P. (Campomyrma)*.

Polyrhachis froggatti Forel, 1910: 89. Syntype workers. Type locality: NEW SOUTH WALES, Bombala (W.W. Froggatt), ANIC, QMBA (examined).

Polyrhachis hexacantha (Erichson); Taylor, 1989: 24. Senior synonym of *P. froggatti* Forel.

Additional material examined. NEW SOUTH WALES (including AUSTRALIAN CAPITAL TERRITORY): NSW (no further data) (W.M. Wheeler) (w); Mt Kosciusko, The Creel, 3000', 14-15.xii.1931 (W.M. Wheeler, Harvard Aust. Exp.) (w); Mt Kosciusko, viii.1957 (Darlingtons) (w); Kosciusko NP, Island Bend, 26.xi.1952 (A. Musgrave) (w); ditto, 24.i.1975 (P. Ward #597) (w); Jenolan Caves (J.C. Wilburt) (w). ACT, Blundells Creek, 2600', 18.xii.1931 (W.M. Wheeler, Harvard Aust. Exp.) (w); Smokers Gap, 35°31'S, 148°54'E, c. 1240 m, 7 & 10.xi.1973 (RJK accs 73.196 & 204) (w). VICTORIA: Mt Buffalo, 4500' (F.E. Wilson) (w); ditto, 5000 ft, 8.ix.1958 (B.B. Lowery) (w). TASMANIA: Tasmania (no further data) (A.M. Lea) (w); Derby (41°08'S, 147°47'E), 10.i.1949 (T. Greaves) (w); Oatlands (42°18'S, 147°22'E), 10.x.1956 (J. McAreavey) (w); University Reserve, xi.2003 (N. Meeson) (w); Trevallyn, 19.iii.1928 (V.V. Hickman) (w).

Worker. Dimensions (syntypes of *hexacantha* cited first, *froggatti* second): TL c. 7.81, 9.27, 7.81-9.27; HL 1.96, 2.25, 1.96-2.25; HW 1.53, 1.87, 1.53-1.87; CI 78, 83, 78-83; SL 2.18, 2.46, 2.18-2.46; SI 142, 131, 131-142; PW 1.22, 1.56, 1.22-1.56; MTL 2.65, 2.96, 2.59-3.03 (2+8 measured).



Figs 8-14. *Polyrhachis* (*Campomyrma*) spp: (8-9, 11-12) *P. hexacantha* (Erichson); (10, 13-14) *P. semipolita* André. (8, 10) head in full face view; (9) petiole in front view; (11, 13) dorsal view; (12, 14) lateral view.

Remarks. *Polyrhachis hexacantha* is very similar to *P. fuscipes* but differs by the sculpturation of the body consisting of very closely spaced reticulate punctations that gives specimens a rather dull, opaque appearance. In contrast, the sculpturation of the body in *P. fuscipes* is distinctly finer, notably on the head, and on the mesosomal dorsum it forms more-or-less longitudinal striae with a somewhat semipolished appearance. The intercalary spines in *P. hexacantha* are rather long, while in *P. fuscipes* they are distinctly shorter. Both species co-occur with *P. smithersi* at Smokers Gap in ACT.

***Polyrhachis semipolita* André, 1896**

(Figs 10, 13-14)

Polyrhachis semipolita André, 1896: 251. Syntype workers. Type locality: AUSTRALIA, Victorian Alps, ANIC (examined).

Polyrhachis hexacantha subsp. *semipolita* André; Emery, 1898: 228. Subspecies of *P. hexacantha*.

Polyrhachis hexacantha subsp. *semipolita* André; Emery, 1925: 179. Combination in *P. (Campomyrma)*.

Polyrhachis semipolita André; Clark, 1934: 72. Revived status as species.

Additional material examined. NEW SOUTH WALES (including AUSTRALIAN CAPITAL TERRITORY): Buccleuch St. Forest (35°21'S, 139°53'E), S of Wee Jasper, 3300 ft, dry sclero, carton nest, 15.x.1995 (B.B. Lowery) (w); Mt Gemini, c. 6000 ft, 22.xii.1975, under snow gums at edge of sphagnum moss swamp (B.B. Lowery) (w). VICTORIA: Emerald, 37°56'S, 145°26'E, 9.xii.1934 (J. Clark) (w); Victoria (no other data) (Narri-Warren) (w). TASMANIA: Mt Nelson, 42°55'S, 147°20'E, 10.xii.1956 (J. McAreavey) (w); ditto, 2.i.1991, dry sclero, ex carton material mound (B.B. Lowery) (w); 4 mi N of Dover (43°20'S, 147°00'E), 15.i.1949 (T. Greaves) (w); 15 km W of Swansea xi.2003 (N. Meeson) (w); Cunningham, xi.2003 (N. Meeson) (w).

Worker. Dimensions: TL c. 7.91-8.87; HL 2.00-2.18; HW 1.68-1.87; CI 84-90; SL 2.25-2.43; SI 126-134; PW 1.43-1.62; MTL 2.59-2.90 (8 measured).

Remarks. With its highly polished body, *P. semipolita* is a very easily recognised member of the *hexacantha* complex. Like the other members it occurs in the mountainous parts of southeastern NSW and the ACT to the Victorian Alps and as far south as Tasmania.

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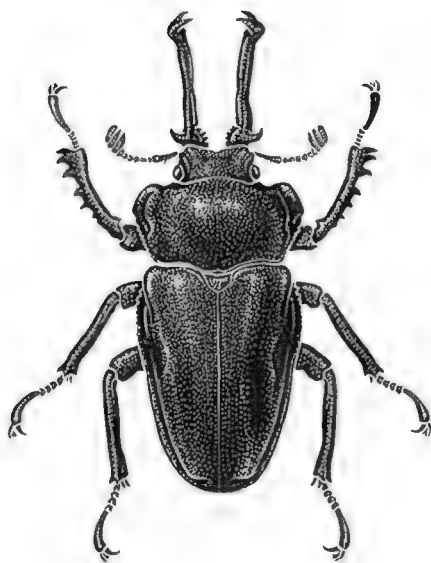
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